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## COMPARING SOUNDSCAPES BASED ON FREE RESPONSE QUESTIONNAIRE SURVEYS

K. Minoura\*, K. Hiramatsu\*\*

\* Yamanashi Women's Junior College, 5-11-1 Iida, 400-0035, Kofu, Japan

\*\* Mukogawa Women's University, 6-46 Ikebirakicho, 663-8558, Nishinomiya, Japan

Tel.: +81-55-224-5261 / Fax: +81-55-228-6819 / Email: [hqj05651@nifty.ne.jp](mailto:hqj05651@nifty.ne.jp)

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### ABSTRACT

In previous papers, the authors reported results of free response questionnaire surveys concerning community response to sonic environment, and also reported a method for comparing sonic environments. In this paper, the authors propose another method for comparing different sonic environments based on analyses of free responses, showing results using free responses obtained in three surveys that the authors carried out. A free response of each respondent to the sonic environment contains one or more statements describing or evaluating the sonic environment. Each statement would contain two parts; specification of the sound source(s) and evaluation of the sound source(s). Focusing on described sound sources and evaluations of them, a free response can be made up a set of sound sources and evaluations. Sources and evaluations are classified into some categories for convenience so that a set of pairs of a source category and an evaluation category can be developed from free responses. Description rates of pairs in different areas, which can be obtained based on this data set, would show one description of sonic environment for residents.

### 1 - INTRODUCTION

In the previous paper, the authors pointed out that a new method was required for rating sonic environment in a different manner from the conventional one taking all sounds heard and perceived by the residents into account, and then reported a method for comparing sonic environments [1]. On the other hand, they also have reported results of free response questionnaire surveys concerning community response to sonic environment [2,3,4]. In this paper, the authors propose another method for comparing different sonic environments based on analyses of results of free response questionnaire surveys about the sonic environment.

### 2 - METHODS

A free response of each respondent about the sonic environment contains one or more statements describing or evaluating the sonic environment. Each statement usually includes two parts; (1) specification of the sound source(s) and (2) evaluation of the sound source(s). Sources and evaluations are classified into some categories for convenience so that a set of pairs of a source category and an evaluation category can be developed from free responses. Then description rates of such pairs in different areas are obtained. The results would provide a description of the sonic environment for residents, that is the soundscape. Free responses about the sonic environment of three surveys in different study areas are used in the following analyses. The question about the sonic environment in the questionnaire was such as "Please describe freely what you feel about 'sounds' at your house or in your neighbourhood." The respondents are of four groups shown in Table 1. Study area I is an area of traditional textile industry [2] and area II is of metalworking industry [3]. The respondents of Groups C and D lived in apartment houses and those of Groups A and B in detached houses. Each of three surveys consisted of the free response questionnaire survey and the observation of the sonic environment including measurement of sound level, which enables the authors to discuss the relation between the respondents' description of their sonic environment and the sound level.

| Group | Study Area  | Type of Residence | N   |
|-------|---|-------------------|-----|
| A     | I; Residential-industrial mixed use, in Kyoto City  | Detached          | 185 |
| B     | II; Residential-industrial mixed use, in Sakai City | Detached          | 115 |
| C     | II; Residential-industrial mixed use, in Sakai City | Apartment         | 146 |
| D     | III; Residential use, in Toyonaka City              | Apartment         | 176 |

**Table 1:** Groups of the respondents.

### 3 - RESULTS AND DISCUSSION

Table 2 shows the description rates of the respondents in the different groups who described in their answers the sound source categories as categorised in the table. These rates are considered to represent the extent of respondents' concern to the sound sources.

The table shows that the respondents of all the groups described the category "automobiles; ordinary" frequently. The respondents of Groups B and C (Study area II) are concerned with the sounds of "industry" as well. It is characteristic of the respondents of Groups C and D, who are residents of apartments, to describe the sounds of "domestic", which are sounds in neighbouring houses such as footsteps, voices, sounds of housework, and so on.

| Category              | Description rate (%) |         |         |         |
|-----------------------|----------------------|---------|---------|---------|
|                       | Group A              | Group B | Group C | Group D |
| Overall               | 40.5                 | 23.5    | 19.2    | 21.0    |
| Automobiles; ordinary | 48.1                 | 48.7    | 52.7    | 66.5    |
| Automobiles; reckless | 4.9                  | 16.5    | 29.5    | 43.2    |
| Automobiles; parking  | 10.3                 | 3.5     | 1.4     | 0.6     |
| Automobiles; others   | 4.3                  | 0.9     | 5.5     | 10.2    |
| Industry              | 28.1                 | 48.7    | 60.3    | —       |
| Construction          | 18.4                 | 0.9     | 0.7     | 1.7     |
| Railway               | —                    | —       | —       | 9.1     |
| Aircraft              | 0.5                  | —       | —       | —       |
| Nature                | 4.9                  | —       | 3.4     | 2.8     |
| Domestic              | 7.0                  | 3.5     | 31.5    | 23.3    |
| In the building       | 1.1                  | —       | 4.8     | 1.1     |
| Neighbourhood         | 23.8                 | 7.8     | 7.5     | 17.0    |
| Dogs and cats         | 5.9                  | —       | 0.7     | 1.1     |
| Unspecified           | 2.2                  | 0.9     | 2.1     | 2.8     |

**Table 2:** Description rates of the sound source categories.

Table 3 shows description rates of the evaluation categories in the different groups. These rates can be considered to represent how respondents evaluate their sonic environment in free responses. In the table, each category of "affirmative" and "impression" is divided in two rows according to whether or not the source evaluated exists in the respondents' environment. The category "existence only" indicates descriptions of the sound source with no evaluation.

"Total existence" in the table shows rates of respondents describing one or more categories indicating existence of any sound sources.

The rates of the category "negative" are the highest in any of the groups, which suggests that the respondents might tend to describe negative elements of their sonic environments more frequently than positive ones in free responses. The category "not effected" indicates existence of the sound source although it is a description of being not effected by the sounds or of having got used to them. The rates of this category increase as those of "negative" increase. The category "nonexistence" indicates nonexistence or fewness of the sound source. It is described by the respondents of Group A by the rate of 27.0%, while the rates of the other groups are less than 10%. The category "quiet" is described frequently by Group A as well.

| Category                   | Description rate (%) |         |         |         |
|----------------------------|----------------------|---------|---------|---------|
|                            | Group A              | Group B | Group C | Group D |
| Negative                   | 47.6                 | 69.6    | 89.7    | 83.5    |
| Existence only             | 40.0                 | 26.1    | 25.3    | 17.0    |
| Not effected               | 9.7                  | 28.7    | 33.6    | 30.1    |
| Affirmative (existence)    | 3.8                  | 3.5     | 2.1     | 0.6     |
| Impression (existence)     | 3.2                  | —       | 2.7     | 1.7     |
| Total Existence            | 82.2                 | 87.0    | 97.3    | 94.3    |
| Nonexistence               | 27.0                 | 5.2     | 7.5     | 8.5     |
| Quiet                      | 23.8                 | 14.8    | 9.6     | 8.5     |
| Affirmative (nonexistence) | 7.0                  | —       | 1.4     | 3.4     |
| Impression (nonexistence)  | 5.4                  | 1.7     | 1.4     | 2.3     |
| Regard                     | 2.2                  | 2.6     | 8.9     | 4.0     |
| In the past                | 13.5                 | 7.8     | 4.8     | 6.8     |

**Table 3:** Description rates of the evaluation categories.

Table 4 shows description rates of the pairs of the source category and the evaluation category frequently described. The description rates of the pair of "automobiles; ordinary" and "negative" increase in order of Groups A, B, C then D. The rates of the pair "automobiles; ordinary" and "existence only" decrease in the same order of the groups as the case of "negative". In the case of "not effected", the rates increase in the same order as the case of "negative". In the case of the source "industry", the relation between rates of "negative" and of "not effected" is similar to the case of "automobiles; ordinary". The pair of "overall" and "nonexistence" is frequently described by the respondents of Group A only. This pair "overall" and "quiet" is also frequently described by the respondents of Group A. The results shows that the respondents of Group A frequently evaluate their sonic environment to be quiet.

| Source                | Evaluation     | Description rate (%) |         |         |         |
|-----------------------|----------------|----------------------|---------|---------|---------|
|                       |                | Group A              | Group B | Group C | Group D |
| Overall               | Nonexistence   | 13.5                 | 1.7     | 2.7     | 4.0     |
| Overall               | Quiet          | 23.8                 | 12.2    | 6.8     | 6.8     |
| Automobiles; ordinary | Negative       | 29.2                 | 33.0    | 41.1    | 55.1    |
| Automobiles; ordinary | Existence only | 16.2                 | 15.7    | 10.3    | 6.8     |
| Automobiles; ordinary | Not effected   | 3.2                  | 12.2    | 11.6    | 16.5    |
| Automobiles; reckless | Negative       | 3.2                  | 14.8    | 26.7    | 40.3    |
| Industry              | Negative       | 6.5                  | 33.9    | 48.6    | —       |
| Industry              | Not effected   | 1.6                  | 11.3    | 15.1    | —       |
| Construction          | Existence only | 12.4                 | —       | 0.7     | —       |
| Domestic              | Negative       | 3.2                  | 1.7     | 20.5    | 12.5    |
| Domestic              | Not effected   | —                    | —       | 11.0    | 5.7     |
| Neighbourhood         | Negative       | 11.4                 | 2.6     | 6.2     | 14.2    |
| Neighbourhood         | Existence only | 10.3                 | 2.6     | 2.7     | 2.8     |

**Table 4:** Description rates of pairs of source and evaluation frequently described.

Table 5 shows the description rates of the pair of "overall" and "quiet" in different categories of sound levels estimated for the respondents. It would be safe to say that the description rate decreases as the level increases in each of groups except for cells containing few respondents. This suggests the possibility to derive dose-response relationship from the results of free response surveys. On the other hand, there are found fair differences in rates of different groups and of the same category of sound level. This suggests there would be confronting factors affecting the evaluation "quiet" besides the acoustic power of sound.

| Respondents | $L_{Aeq}$ (dB) |        |          |         |        | Total    |
|-------------|----------------|--------|----------|---------|--------|----------|
|             | 50             | 55     | 60       | 65      | 70     |          |
| Group A     | 50.0%          | 20.0%  | 29.0%    | 17.6%   | 0.0%   | 23.8%    |
|             | (5/10)         | (7/35) | (20/69)  | (12/68) | (0/3)  | (44/185) |
| Group B     | 14.3%          | 23.7%  | 7.0%     | 3.8%    | 0.0%   | 12.2%    |
|             | (1/7)          | (9/38) | (3/43)   | (1/26)  | (0/1)  | (14/115) |
| Group C     | —              | 0.0%   | 9.3%     | 0.0%    | —      | 6.8%     |
|             | (0/0)          | (0/2)  | (10/108) | (0/36)  | (0/0)  | (10/146) |
| Group D     | —              | 0.0%   | 11.1%    | 6.5%    | 5.3%   | 6.8%     |
|             | (0/0)          | (0/2)  | (4/36)   | (4/62)  | (4/76) | (12/176) |

**Table 5:** Description rates of the pair of "overall" and "quiet" in different categories of sound level estimated for the respondents.

#### 4 - CONCLUSION

In this paper, a method for the comparison of different sonic environments has been presented based on analyses of results of free response questionnaire surveys about the sonic environment. It is suggested from the results that the method enables to compare sonic environments recognised by residents, and to explore relationship between it and the noise exposure. The method would be significant to approach to the comparison of residents' whole experiences concerning their sonic environment.

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