

Urban Noise Annoyance Between 2001 and 2013 – Study in a Romanian City

Diana Ioana POPESCU, Iuliana Fabiola MOHOLEA, Radu Mircea MORARIU-GLIGOR

Technical University of Cluj-Napoca, Faculty of Machine Building
B-dul Muncii 103-105, 400641 Cluj-Napoca, Romania; e-mail: Diana.Popescu@mep.utcluj.ro

(received March 17, 2013; accepted April 24, 2013)

The paper presents results of three socio-acoustic surveys conducted in an interval of twelve years, between 2001 and 2013, in a large Romanian city, Cluj-Napoca. The purpose of the surveys was to assess the awareness of residents on urban noise and the extent to which the noise environment affects their everyday life, behavior and health. The surveys were conducted in 2001, 2009 and 2013. The questionnaire used in the first survey had 16 questions and it was verified prior to study through a pilot survey, being corrected and improved. For the second and the third study, the questionnaire was enriched with eight more questions, regarding essentially the description of the residential area, criteria for its selection and also awareness about the noise map of the city. The analysis of responses defines the main characteristics of the local pattern of annoyance and reaction of the urban population to the environmental noise.

Keywords: noise annoyance, urban noise, socio-acoustic survey.

1. Introduction

Most studies related to the noise annoyance in urban environment use two assessment methods, usually combined, depending on the specific situation and needs. The first method describes the existing noise situation by means of noise exposure indicators provided by a noise map of the area, with the possibility to model other different noise scenarios, characterizing the development or re-organization of the urban area (SOMMERHOFF *et al.*, 2004; LEE *et al.*, 2008). Noise maps are developed within specialized software, resulting in a computer visual model of the noise situation, with a precision which depends on the volume and accuracy of input numerical and graphical data. A map must be validated and corrected based on noise measurements values. With the entry into force of the EU Noise Directive, noise mapping methods were merged and unified, action which led to the obtaining of comparable results.

The second method aims to find out the population response to urban noise through a sociological study (KLÆBOE *et al.*, 2004). This approach is important for the assessment of exposure-effect relationship, described by quantifiable indicators of the presence and intensity of certain features. It is considering, in this case, the evaluation and interpretation of the subjective side of the issue, by taking into account

both acoustic and non-acoustic factors, in their interaction, when characterizing the short-term and long-term effects of noise pollution on the population in different urban areas. Non-acoustic factors influencing noise nuisance are numerous and can be grouped into three main categories: situational factors (induced by the location of noise source and urban context), individual factors (socio-demographic and attitudinal, relatively stable over time but variable from person to person) and social factors (relevant in the context of social groups: lifestyle, perception of noise source and its time evolution, attitude of responsible persons and others). The purpose is to find what people think and feel about the noise in their residential area, how annoyed they are, how sensitive to noise, how informed and warned about its negative effect on health.

There are studies which combine measurement and survey methodology (SKINNER, GRIMWOOD, 2005; LAM *et al.*, 2009) and others developing new methods, models and theories for predicting effects of environmental noise on people and defining exposure-effect relationship (BATKO, PAWLIK, 2012; KRYTER, 2009; MIEDEMA, OUDSHOORN, 2001; MARIS *et al.*, 2007) or for improvement the urban acoustic environment (KOMPALA, 2011)

This paper presents parallel results of two socio-acoustic surveys undertaken in 2001 and 2009 in the city of Cluj-Napoca, Romania and partial results of

a third survey which is in progress during the year 2013. They are related to studies which assess the noise environment of the city, in the context of noise mapping actions.

2. The area of study and the general noise context

The city of Cluj-Napoca is located in the North-Western region of Romania, being the capital of Cluj County and an important cultural, scientific and educational centre. According to a statistical study made in August 2000, the stable population of the city consisted of 316001 inhabitants. An estimation from July 2007 indicated 310243 inhabitants with registered residence in Cluj-Napoca and also more than 100000 students and 50000 non-resident employers. Population Census from 2011 showed that the stable population has decreased to 309136 inhabitants.

For the study in 2001, a distribution of population in ten districts was considered. In later years, besides the existing districts have been developed new ones, mainly due to enlargement of the residential area towards the limits of the city. Some of the new districts were formed by reorganizing existing ones. Thus the studies in 2009 and 2013 considered the population grouped in 19 districts. Ten of them are new districts, which concentrate in present about 28% of the city population.

Cluj-Napoca City is the third – in terms of number of inhabitants – of the nine Romanian cities that have made the noise map and action plans for reducing ambient noise, as required in the Directive 2002/49/EC and equivalent Romanian legislation GD nr. 321/14.04.2005. The noise mapping action was started in the second half of 2006, being coordinated by the local public administration. Specific information related to noise map, noise exposure and action plans was made available to the public on the website of the town hall, starting with 2007. According to this noise assessment, a total percentage of 6.67% of the stable population in Cluj-Napoca represents the estimated number of people exposed to excessive noise by road traffic, rail, aircraft and industrial activities.

3. Sociological surveys in 2001, 2009 and 2013

3.1. Methodology 2001

The purpose of the sociological investigation was to know the opinion of the inhabitants on the noise levels and sources of noise in Cluj-Napoca city, including the situation in districts, and to find if people have taken actions to reduce noise and to improve the acoustic comfort of their dwellings. Also, we aimed to find out the extent to which the environmental noise affects their daily activities, behavior and health. The

questionnaire was developed after a preliminary study of the existing situation in the city, which included the collection of related data necessary to establish the sample volume and composition. A pilot study was conducted for field-testing and refinement of the questionnaire.

The number of questions was set at 16, so that the questionnaire was not boring and covered all stated subjects. Since the questionnaire was one of opinion, following aspects were taken into account: the questionnaire contained a series of open questions, to let the respondent to formulate his/her own opinion on the issue; the respondent had the possibility to motivate a specific answer; pre-coded questions were asked in order to measure the intensity of subjects' opinion. Among other items, the questionnaire asked about current occupation, field of activity, education, age, residential district. A number of 238 questionnaires were selected from the returned number and their answers were structured and analyzed in a database program and then compared with objective data collected on the preliminary documentation (POPESCU, MORARIU-GLIGOR, 2004).

3.2. Methodology 2009

The aim of the study was to determine the current reactions and response of residents related to the urban noise and changes in attitudes compared to 2001. An improved form of the questionnaire was developed, adapted to the intended purpose of establish references for: level of knowledge and awareness of environmental noise in urban areas, by population; information of citizens about the noise mapping action and its results; main negative effects and reaction of inhabitants to the noise pollution, specific forms of behavioral; hierarchy of different sources of urban noise, depending on the level of perception and disturbance of residents; involving of citizens in authorities effort to improve urban acoustic environment; citizens options on the most effective way of information that should be used by authorities.

The survey questionnaire contained 24 questions, being dimensioned to require no more than 20 minute attention and specifically design to reflect the three major classes of non-acoustic factors that influence noise annoyance: situation, individual and social factors. Questions were grouped in four categories: residential zone description in relation with traffic and environmental noise; annoyance due to different noise sources and effects on peoples' habit; information, trends and attitudes towards environmental noise; identification of respondent as occupation, sex, age and education.

The questionnaire was distributed in 19 districts of the city, during May-September 2009. A number of 325 questionnaires were processed, from 348 returned,

after elimination of those containing improbable or inconsistent answers (POPESCU, MOHOLEA, 2010).

3.3. Methodology 2013

The same questionnaire was used for the study in 2013, which has started in February. Only partial results are available, from the processing of 135 returned valid questionnaires, grouped according to age, education and occupational state, as presented in Table 1.

Table 1. Responses by age, education and occupational state (2001; 2009; 2013 – partial).

		Year of the survey		
		2001	2009	2013
Age	18–30	98	122	33
	31–50	113	128	72
	51–70	21	70	25
	over 70	6	5	5
Education	≤10 classes	5	6	5
	High school	132	114	45
	University	101	205	85
Occupational state	Employed	207	222	94
	Retired	12	42	19
	Student	10	24	11
	Unemployed	4	6	9
	Other situation	5	31	2

4. Results and discussions

Results obtained from the two sociological studies in 2001 and 2009 are presented as follows in combined charts. They have been released as percentage, taking as basis the total number of valid responses – Fig. 1 to Fig. 6. Survey results from 2013 were not included in these charts, as they are currently only partial results,

which represents about a quarter of the estimated total responses. Only the questions common to the both questionnaires were suited for a parallel presentation of results. Because there were some changes in the wording of the noise annoyance questions and quantification between the surveys, there were some situations in which it was necessary to re-group the answers on common criterions.

In describing the noise level of their residential area (Fig. 1), subjects of the study in 2001 and 2009 had similar opinion. A lot of them (41.6%, respectively 37.2%) characterized their noise environment as “Medium”, on a five point answer scale and the other answers are equilibrated on the left and right side of the scale. Responses recorded in 2013 indicate a decrease in the number of people who are disturbed by noise in their residential area: 6.7% “Very low”, 32.6% “Low”, 38.5% “Medium”, 19.3% “High”, 2.9% “Very high”.

At the question: “Indicate the main source of noise in the vicinity of your home” the percentage of answers: “Light vehicles” increased from 35.4% in 2001 to 42.0% in 2009 and 49.8% in 2013 (Fig. 2). The situation is explainable, considering the sharp increase of the road traffic in the last twelve years. Decreased percentage of responses: “Heavy vehicles” may be due to the fact that some mandatory routes were established for heavy traffic through the city in the recent years, in the absence of a ring road surrounding the city. To note that a significant number of responses indicated neighbors as the main noise source in all three studies. At this question subjects might choose one or more variants of answer, the reference being the total number of variants in each study.

The quantification of annoyance induced by the environmental noise was made on a four point scale (Fig. 3). In the first study 62.2% of respondents declared to be annoyed and very annoyed by the noise in their residential area, since in 2009 only 47.7% of the subjects indicated these two degrees of annoyance, in 2013 the percentage decreased to 35.5%.

Question 7/7: “Describe the noise level of your residential area”

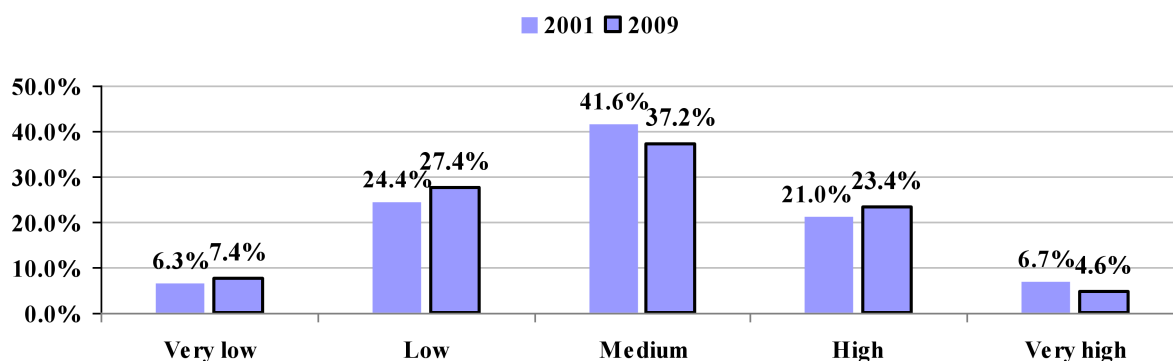


Fig. 1. Proportion of responses describing the noise level in the residential area (2001, 2009).

Question 8/8: "Indicate the main source of noise in the vicinity of your home"

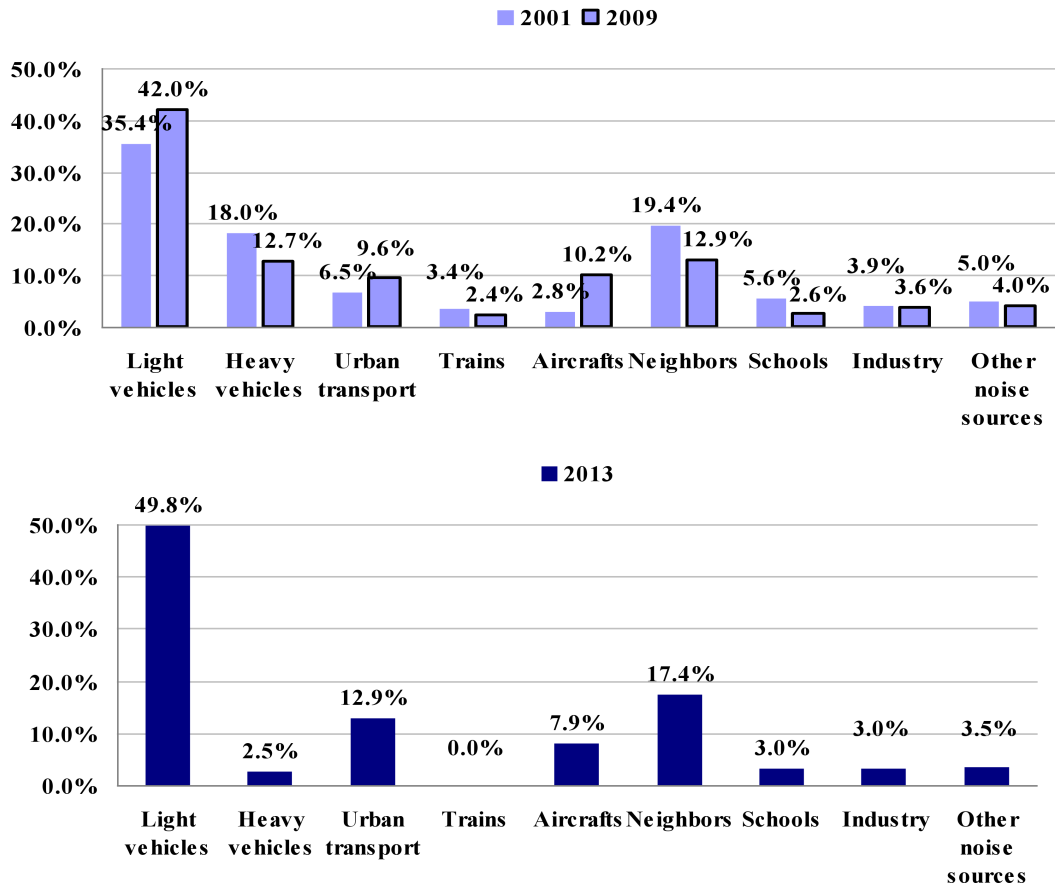


Fig. 2. Proportion of responses pointing the main source of noise in home vicinity.

Question 9/9: Annoyance due to the environmental noise

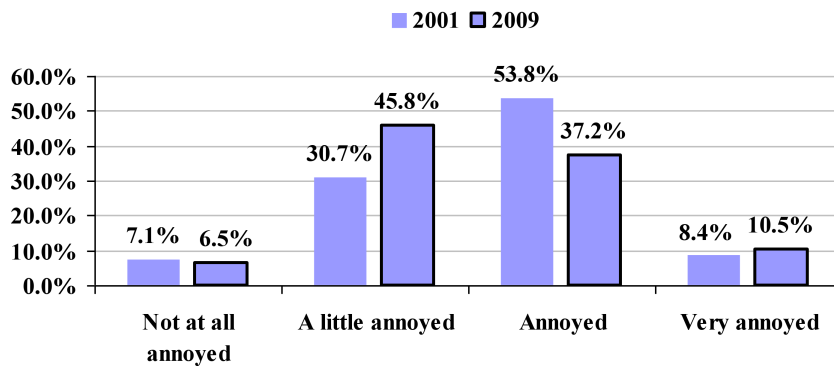


Fig. 3. Proportion of responses describing the annoyance due to the environmental noise.

For the time of the day most affected by the environmental noise, all three studies indicated mainly the time interval between the hours: 15⁰⁰ (3⁰⁰ PM) and 22⁰⁰ (10⁰⁰ PM). An explanation might be that for most of the subjects this is the afternoon rest time period, spent at home. Figure 4 presents responses from 2001 and 2009, grouped by respondents' age.

In all three studies subjects were asked to indicate experienced harmful effects produced by the environ-

mental noise. The pre-defined answers measuring these items were more detailed in the questionnaire used in the last two studies. For the studies in 2009 (POPESCU, MOHOLEA, 2010) and 2013 (preliminary results) responses are indicated in Table 2. Fatigue and nervousness were mostly selected by subjects. The missing percent up to 100% indicates other possible effects. The answers were re-grouped to compare the studies in 2001 and 2009 (Fig. 5). Subjects could choose more

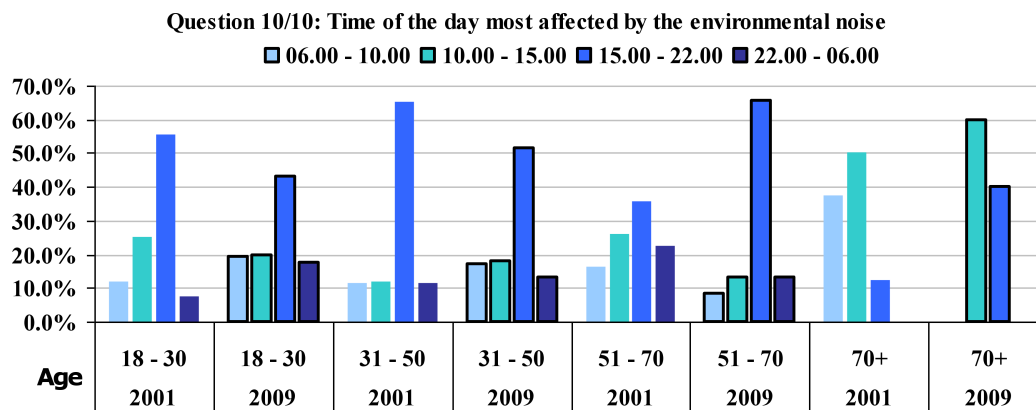


Fig. 4. Proportion of responses, sorted by age of the subjects, pointing the time of the day most affected by the environmental noise (2001, 2009).

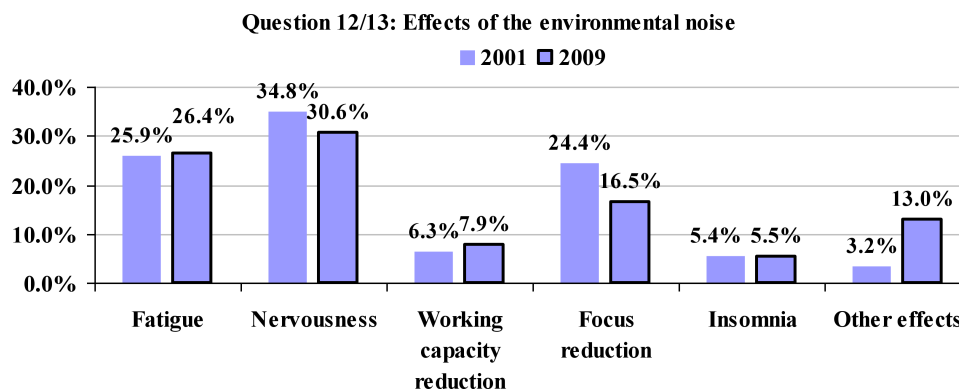


Fig. 5. Proportion of responses describing harmful effects of the environmental noise.

Table 2. Harmful effects of the environmental noise (2009 and 2013 – partial results).

Noise effects	Year of the survey	
	2009	2013
Fatigue	26.4%	24.4%
Nervousness	17.6%	24.4%
Anxiety and agitation	12.6%	14.8%
Depression	0.4%	2.4%
Reduction of working capacity	7.9%	2.9%
Focus reduction	16.5%	11.0%
Discomfort by masking other sounds	12.5%	12.4%
Insomnia	5.5%	3.8%

than one pre-defined answer and the percentage was calculated as report to the total number of answers selected by respondents.

In the end of the questionnaires subjects were asked if they have taken any action in order to improve the acoustic comfort of their dwelling. The number of “Yes” answers varied from 21% in 2001 to 51.4% in 2009 and 31.9% in 2013. Subjects have been asked then to indicate the actions they have done. Figure 6 shows that the mentality of inhabitants has changed between 2001 and 2009, many of them renouncing to write complains to responsible authorities but deciding to

take measures for reducing the annoying noise in their home environment. The situation is similar in 2013, when responses are as follows: 5.3% “complaints to authorities”, 24.5% “acoustic isolation of dwelling”, 5.3% “change of the residential area”, 63.2% “change windows” and 1.7% took other noise reduction measures. This fact may also explain the decrease of the percentage of persons which have declared to be annoyed and very annoyed by the environmental noise from 62.2% in 2001 to 47.7% in 2009 (Fig. 3) and 35.5% in 2013.

One of the issues identified by the study in 2009 was related to the poor information of population about the noise map of the city and measures undertaken by local authorities to reduce noise pollution in the urban area and to frame the noise environment in admissible limits. The subjects were asked about urban noise studies performed in the last years and responses were as follows (POPESCU, MOHOLEA, 2010): 4.8% “Noise map of the city”, 3.9% “Noise measurements”, 0.9% “Noise questionnaires”, 36.5% “No studies”, 53.9% “Don’t know”. More than half of respondents (52.0%) didn’t know if measures have been taken to reduce noise pollution in the city and 26.8% considered that no measure has been taken.

After four years the situation was not improved. The 2013 survey has recorded the following percentages of response to the same question: 2.8% “Noise

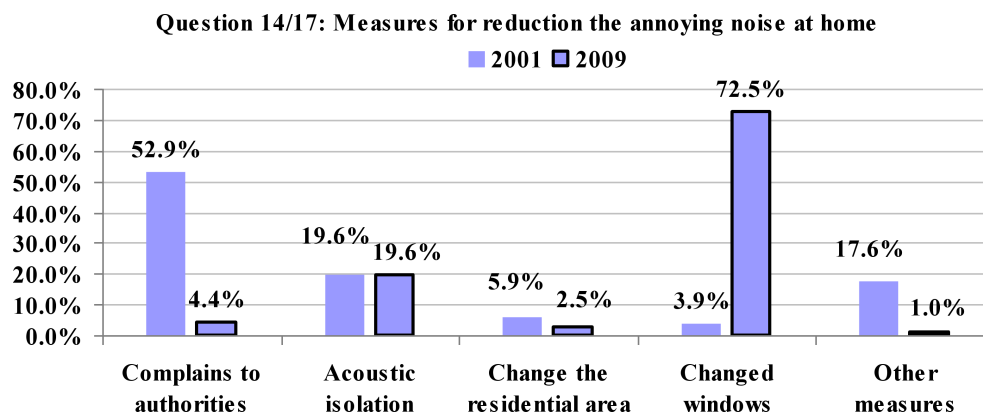


Fig. 6. Proportion of responses related to actions for reduction of annoying noise.

map of the city”, 2.8% “Noise measurements”, 4.2% “Noise questionnaires”, 32.4% “No studies”, 57.8% “Don’t know”. In terms of actions to reduce urban noise, 64.4% of responses were “Don’t know” and 18.5% indicated “No measures”.

5. Conclusions

Over the past twelve years the growing traffic in the city of Cluj-Napoca has produced important changes in urban noise situation. At the same time there has been a growing concern for reducing the effect of noise on inhabitants. EU Noise Directive requirements have led to the development of the first noise map of the city, followed by action plans to reduce noise. This paper aimed to observe how these changes were perceived by the citizens and also to provide a reference for the noise annoyance estimation for planning purpose in Romania.

The analysis defines the main characteristics of the local pattern of annoyance, reaction and response of the urban population to the environmental noise and gives information on the changes of noise perception over a time period of twelve years. From the point of view of noise annoyance the situation has improved in the last years, but the insufficient dissemination of information about noise as a hazard is still an issue and needs more emphasis.

Acknowledgment

The paper will be presented during the 16th International Conference on Noise Control 2013.

References

- BATKO W., PAWLK P. (2012), *New Approach to the Uncertainty Assessment of Acoustic Effects in the Environment*, Archives of Acoustics, **37**, 1, 57–61.
- KLÆBOE R., AMUNDSEN A.H., FYHRI A., SOLBERG S. (2004), *Road traffic noise – the relationship between noise exposure and noise annoyance in Norway*, Appl. Acoustics, **65**, 893–912.
- KOMPALA J. (2011), *A System for Management of Urbanized Areas in the Aspect of Acoustic Effects*, Archives of Acoustics, **36**, 1, 57–63.
- KRYTER K.D. (2009), *Acoustical model and theory for predicting effects of environmental noise on people*, J. Acoust. Soc. Am., **125**, 6, 3707–3721.
- LAM K.-C., CHAN P.-K., CHAN T.-C., AU W.-H., HUI W.-C. (2009), *Annoyance response to mixed transportation noise in Hong Kong*, Appl. Acoustics, **70**, 1, 1–10.
- LEE S.-W., CHANG S.I., PARK Y.-M. (2008), *Utilizing noise mapping for environmental impact assessment in a downtown redevelopment area of Seoul, Korea*, Appl. Acoustics, **69**, 704–714.
- MARIS E., STALLEN P.J.M., VERMUNT R., STEENSMA H. (2007), *Noise within the social context: Annoyance reduction through fair procedures*, J. Acoust. Soc. Am., **121**, 4, 2000–2010.
- MIEDEMA H.M.E., OUDSHOORN C.G.M. (2001), *Annoyance from transportation noise: Relationships with exposure metrics DNL and DENL and their confidence intervals*, Environ. Health Perspectives, **109**, 4, 409–416.
- POPESCU D.I., MORARIU-GLIGOR R. (2004), *Aspects of the Environmental Noise in Cluj-Napoca*, Proceedings: The Second International Conference of SRA on Acoustics and Vibrations, Bucuresti, 51–57.
- POPESCU D.I., MOHOLEA I.F. (2010), *Monitoring the reaction and response of people to urban noise*, Archives of Acoustics, **35**, 2, 237–244.
- SKINNER C.J., GRIMWOOD C.J. (2005), *The UK noise climate 1990–2001: population exposure and attitudes to environmental noise*, Appl. Acoustics, **66**, 231–243.
- SOMMERHOFF J., RECUERO M., SUAREZ E. (2004), *Community noise survey of the city of Valdivia, Chile*, Appl. Acoustics, **65**, 643–656.