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Miriam Weber

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The soundscape of nature areas: assessment and review of research approaches

M. Weber

DCMR Environmental Protection Agency, Parallelweg 1, 3112 NA Schiedam, Netherlands
miriam.weber@dcmr.nl

The Environmental Noise Directive requires authorities to delineate (nature) areas where the acoustic quality is good, and to protect these areas. In the Netherlands, since decades provinces have delineated so-called quiet areas cf. the Environmental Protection Act. In line with the noise abatement paradigm acoustic parameters were applied as maximum allowed levels (e.g. 40 dB Lday) and specific activities near or in these nature areas were restricted. Underlying reasons for preserving the (acoustic) quality of the quiet areas, such as restoration for humans or effects on animals, were hardly considered. Interestingly, some regional authorities adopted the END as a shift from noise abatement towards soundscape approaches. In the Province of South Holland (acoustic) quality in two quiet areas is assessed applying insights from international soundscape research. A two step approach is applied; a 'classic' approach of measuring noise indicators. And parallel to measuring visitors and people living in the vicinity of the areas are surveyed, using a questionnaire on sound perception, overall quality assessment of the area, noise annoyance at home et cetera. The paper will discuss (dis)advantages of the approach applied, and will provide suggestions for standardization of soundscape research in urban as well as nature areas.

1 Introduction

Soundscape research is gaining much interest from a diverse range of scholars and researchers. International conferences address the topic in technical sessions and academic journals regularly publish newest insights from all over the world.

An ISO working group started working since some years on standardized approaches and recently proposed to define soundscape as "perception of the acoustic environment as perceived by people in that place, in context". The next phase in the working group's activities will consist of standardization of soundscape research and methodologies. The forthcoming paper by T. Gjestland will probably prove a good basis for further discussions on standardized approaches, and is eagerly looked for.

As Lam et al. [1] state, knowledge of which soundscapes people prefer and what affects their preferences is instrumental in defining soundscapes of "good quality". The EU Environmental Noise Directive is not very clear and specific on these definitions, although recognizing the need to protect areas of good acoustic quality. Reasons given are to provide retreat from urban stress and to recuperate psychologically. Research [e.g. 2] has underlined the positive, health and stress-reducing, effects of green and quiet areas.

The Environmental Noise Directive distinguishes quiet urban areas and quiet natural areas. Abundant research has been published on urban public spaces or quiet urban areas. Examples are Schulte-Fortkamp with a specific focus on the local experts [3], and Adams et al. on noise policy and sustainable urban soundscapes [4], and Payne et al [5]. In addition, there is an increasing number of conference proceedings and papers on soundscape research in urban areas describing the approaches applied. Examples are Weber [6] on methodologies for assessing soundscapes of parks in Rotterdam, Nilsson and Berglund [7] in Sweden, Brambilla and Maffei [8] in Italy.

With respect to quiet natural areas or the countryside Lam et al. refer to various studies on outdoor recreationists experience, and add their insights based upon a Hong Kong study.

In this paper the main focus will be on the methods applied for assessing the soundscape relying on peoples' perception. Undeniably however, physical measurements, e.g. measurements of (psycho)acoustic indicators, are required as well, and as such are part of the research of the

soundscape of the quiet, natural areas in the province of South Holland.

Notably, there seems to be abundant discussions and convergence on the – (psycho)acoustic – indicators to be measured, and literature discussing measurement approaches and variables. Nevertheless, limited scholarly discussions can be found on field survey approaches, assessing human perceptions. Soundwalks, open interviews, creativity and design 'contests' or questionnaires, have been applied. However, discussions on for example research design or the structure of questionnaires seem to be limited available. This paper attempts to initiate discussing and sharing experience and lessons learned.

2 Quiet natural areas

2.1 Policy approaches on nature areas

The Dutch Environmental Management Act requires competent authorities to delineate and protect quiet natural areas (in Dutch: stiltegebieden), comprising at least the following types of areas: (i) protected nature areas, and (ii) wetlands as designed by the Ramsar Convention. Quiet natural areas should have a certain seize, tranquility and added value for recreation or fauna. Finally, the quiet natural area are delineated guaranteeing noise levels not higher than 40 dB Lden.

The province of South-Holland in the western part of the Netherlands has defined some specific rules and requirements for protection of tranquility or quietness. Examples are the following: motorized touring and large outdoor events are prohibited, the speed of motor boats is restricted, and the use of model airplanes and cars is prohibited. Sounds from tractors or other so-called area specific sounds, however, are allowed. According to the authorities, and proven by some scholars [e.g. 9] these sounds, sometimes even from non-natural sources, belong to these areas. The natural area as such provides the context for perceiving these sounds as pleasant or in accordance with expectations et cetera.

Spatial planning regulations limit settling of SME activities, farming activities and residential housing within or near the natural areas. In addition, helicopter landing spots or airports are not to be situated within 1.000 meter.

2.2 Study areas

In 2010 the province of South Holland initiated a public awareness campaign on its 16 quiet, natural areas. The aim is to improve awareness of the citizens, and to increase visits to the areas; underlining the positive qualities of the areas such as tranquility, quietness and refuge from the noisy city. In addition, the noise action plan cf. the EU Environmental Noise Directive defined monitoring actions and the application of low noise road surface on roads near these quiet natural areas. Consequently, the DCMR Environmental Protection Agency selected two areas for monitoring and assessing the acoustic environment in 2011. The study areas are the following:

- 1) Midden Delfland: appr. 2.700 ha, located near the large cities of the Hague, Rotterdam and Delft. The natural area is an open meadow area comprising peat meadows, water and farms.
- 2) Krimpenerwaard-Alblasserwaard: appr. 12.700 ha, located in the Green Heart and surrounded by the rivers Lek and Hollandsche IJssel. This is an open meadow area as well with many historical farms.



Figure 1: Study area Midden-Delfland



Figure 2: Study area Alblasserwaard

2.3 Methodology

In this study human perception of the soundscape of both selected natural areas is conducted by collecting acoustical data as well as human perception response data in situ. Responses were measured by questionnaires, with approximately 100 interviews successfully completed at two sites per natural area.

Interviews were conducted by students, at small roads used by hikers and/or bikers. The survey targeted visitors aged 18 years or above; some living in the vicinity of the area and others visiting the natural areas for specific reasons (for the first time or frequently). The overall response rate was almost 100%, as limited or none of the people asked for the interview were unwilling to cooperate. The field surveys were conducted on weekdays in November and December; this might have influenced the results because of the cold(er) weather compared to doing research in summer time.

The data obtained were analyzed using Statistical Package for the Social Science (SPSS) for Windows version 17.0. Statistical analyses consisted of Pearson, Spearman and ANOVA analyses. Aim of these analyses is to define relationships between human preferences and perceptual variables using correlation and stepwise regression analysis, similar to Lam et al. A secondary aim of these analyses is to assess which questions, answers and coding mechanisms prove to be practical in usage *and* provide sufficient scientific evidence to base conclusions.

At the same days of the field surveys, acoustic measurements have been carried out. The analyses of these data will follow and linked to field survey results later in 2012. In that stage relationship between human preference and various acoustical variables will be assessed. These analyses will however not be part of this paper.

2.4 Questionnaire

The questionnaire applied in the field survey is based upon work from COST Action Soundscape [10]. The structure of the questionnaire is as follows:

- (i) general questions on: reason, frequency, duration, companionship, day of week, time of day of the visit;
- (ii) questions on sound(scape): characterization of soundscape, audibility of sound sources, annoyance from sound sources, pleasantness of sound sources, acoustic quality;
- (iii) questions on the environmental surroundings, the natural area: environmental quality, characterization of the area e.g. tranquility, natural quality, safety, pleasantness;
- (iv) questions on personal data: male/female, age, education, occupancy, zip code;
- (v) questions on living conditions: distance between home and natural area, acoustic quality at home, annoyance from sound sources at home

Most of these questions have closed, easy to code, answer categories or scales ranging from 1 to 5. In addition, a few open questions were added, asking the visitors which improvements they would like to propose regarding the soundscape and the natural area itself.

The aim of these latter questions is to provide the province with specific suggestions for management and improvement of the natural areas, from the specific points of view and expectations of the visitors.

3 Results

3.1 Soundscape quality

Berglund et al. [11] defined verbal descriptions of soundscape qualities to be applied in, for example, soundwalks. The verbatim used are the following:

Unpleasant	–	pleasant
Uneventful	–	eventful
Chaotic	–	quiet
Boring	–	exciting

In assessing the acoustic environment in urban parks in Rotterdam [6] these descriptions have been translated into Dutch and applied during interviewing citizens. During that study respondents seemed to be distracted and misled by some verbal descriptions, such as the Dutch translation “opwindend” of “exciting” and the dichotomy of uneventful – eventful. Therefore in the study in the quiet natural areas the description “spannend” instead of “opwindend” was used, as well as “kalm” instead of “stil” (for quiet). The respondents in this study felt more comfortable with these descriptions of the acoustic environment. Nevertheless, answers varied strongly on the verbatim “weinig afwisselend” (uneventful), “afwisselend” (eventful), and “monotoon” (boring). This could indicate limited descriptive value of these verbatim; specifically compared with the other verbatim with limited variance. For example 46,8% resp. 65,3% of the respondents stated that the descriptions “exciting” and “chaotic” are not applicable.

Significant correlations were found between the descriptions:

- chaotic and exciting (,416)
- calm and annoying (-,410)
- calm and pleasant (,499)
- chaotic and annoying (,451)

3.2 Sound source categories

As discussed by Brown [9] preservation of high acoustic quality in natural areas is required for protecting wildlife. As such intrusion from human-generated sounds should be prevented. Another objective of maintaining the quality of the soundscape in natural areas is human appreciation, enjoyment and positive effects on stress and other negative health effects. In questioning users of these areas preferred sounds, in contrast to the frequently applied, ISO standardised question on noise annoyance, sounds of moving water, sounds of nature, and sounds of other people.

Respondents in the study areas were asked to indicate whether specific sound sources were audible during the visit of the natural area. Sound sources applied are the following: (i) traffic sounds, (ii) mechanical sounds, (iii) human sounds, and (iv) nature sounds.

Table 1: Audibility of sound source categories

	Traffic	Mechanic	Human	Nature
Mean	2,79	1,81	2,12	4,16
Std. Dev.	1,43	1,13	1,19	1,00

As can be concluded from Table 1 respondents indicated that specifically nature sounds were audible, although traffic sounds were recognized as well.

Weak correlations were found between nature sounds and calm (,204) and nature sounds and pleasant (,246).

3.3 Acoustic environment

In order to assess perception of the afore mentioned sound sources, the respondents were asked to indicate whether certain sound sources were considered annoying and/or pleasant (in two separate, closed questions ranking from 1 (do not agree at all) to 5 (agree fully)).

Surprisingly most sound sources listed were considered not (at all) annoying. Varying between 64,4% of the respondents considering airplanes not annoying during the visit up to 90,8% of the respondents considering water not annoying. On the other hand, 54,3% of the respondents consider motorized 2-wheelers as not annoying, and 21,4% of the respondents considered road traffic not annoying. Or in other words, these both sound sources are more frequently considered annoying than all other sources listed.

When asking for pleasantness of sound sources, higher percentages are found. Indicating that “annoying” and “pleasant” are not considered as opposite, dichotome verbatim descriptions for various sound sources. For example, 80,9% of the respondents answered that airplanes are not pleasant, and 86,7% of the respondents considered motorized 2-wheelers as not pleasant.

Correlation between pleasantness of sound sources and soundscape quality descriptions were limited and very weak. Correlation between annoyance of sound sources and soundscape quality descriptions was weak up to (,325) for road traffic / annoying.

A preliminary conclusion is, that the use of both questions on pleasantness and/or annoyance of sound sources seems to lead to limited insights.

In addition, respondents were asked to state whether they agreed with the proposition that the acoustic environment of the natural area is good (ranging from 1 do not agree up to 5 fully agree).

Some weak correlations between soundscape quality descriptions and acoustic environment were found for the following: annoying (-,380), calm (,378), pleasant (,335) and chaotic (-,243).

3.4 Appreciation

The questionnaire comprised questions on the overall quality of the natural area as well; after the acoustic/soundscape questions. Remarkably, the landscape (visual) qualifications have stronger relations with the overall appreciation of the natural area than the acoustical qualifications.

The following correlations with overall appreciation of the landscape were found: natural quality (,515), pleasant area (,510), tranquillity (,474), clean (,402), and visual appearance (,471). Finally, a weak correlation was found for safety (,270).

Interestingly is the correlation between the appreciation of the landscape and the acoustic environment, for the four studied areas, varying between ,303 to ,626 representing average to fairly strong correlations.

4 Future steps

During the next months field survey data will be combined and evaluated with the data from the acoustic measurements. As Brown [9] stated, the context of the acoustic experience is critical, and as such loud sounds of wanted sounds might be appreciated whereas low sounds of unwanted can be annoying and unpleasant for the humans visiting the natural area. These sound sources, to be distinct in various categories of sources as well as wanted versus unwanted sounds, will have to be identified. This is specifically critical as managing soundscapes in a place involves the planning and design of the acoustic environment that have relevance to the perception of the acoustic environment of those people who use that space. Or as Brambilla recently stated, the study on soundscapes should include subjective ratings on how the soundscape is perceived by the people experiencing it, considering also the different motivations (residents, tourists...) where applicable. This is also important for the selection of mitigation actions aimed not only to reduce the noise levels but also to improve the acoustic environment towards a better matching with people's expectancy.

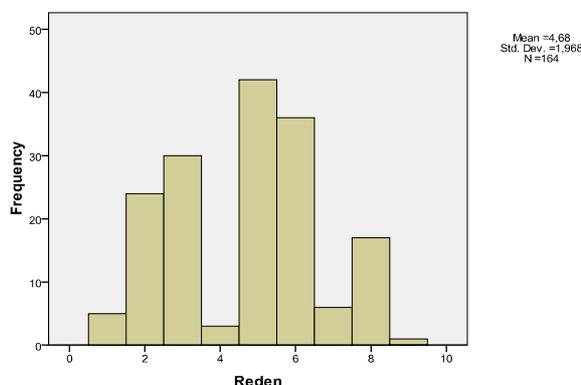


Figure 3: reason for visit (highest scores on walking the dog, hiking, nature, tranquility/relaxation)

As a consequence the further analysis will have to pay specific attention to possible differences in appreciation and perception of the natural areas by the different "users". This fits the approach promoted by Brigitte Schulte-Fortkamp [3] claiming that "local experts are those people in action that live in a certain area under scrutiny and provide their expertise e.g. through evaluation processes such as sound walks and different kind of open interviews. [This] will give a focus for the analysis of the acoustical as well as qualitative data.[..] The attitude and the listener's expectations and experiences are significant parameters which have to comprehend the different perceptions and evaluations with regard to specific stimuli completely.

Moreover the knowledge people have concerned the area they are living in is of most importance."

The results of the study will be evaluated regarding the approach applied and further improvements will be implemented in the methodology. Finally, recommendations on the specific areas studied will be provided to the province and incorporated in the noise action plan that will be drafted during the next months in line with the requirements of the EU Environmental Noise Directive.

5 Conclusion

As stated above this research is work in progress and most of the field survey data has not been analysed by the time of writing this paper. Nevertheless, the author aimed to start discussions on the methodologies applied in soundscape research, with a specific focus on assessing human perception. Comments, suggestions and best practices are appreciated.

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