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Acoustics — Soundscape —

Part 2: Data collection and reporting requirements

Acoustique — Paysage sonore —

Partie 2: Collecte de données

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Contents

Page

Foreword

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This document was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

A list of all parts in the ISO 12913 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The ISO 12913 series on soundscape was developed in order to enable a broad international consensus and to provide a foundation for communication across disciplines and professions with an interest in soundscape. ISO 12913-1 provides the definition of and a conceptual framework for the term “soundscape”.

The concept of soundscape was adopted to provide a holistic approach to the acoustic environment, beyond noise, and its effect on the quality of life. Soundscape suggests assessing all sounds perceived in an environment in all its complexity. To do this, soundscape studies use a variety of data collection related to human perception, acoustic environment and context. Importantly, the study of soundscape relies primarily upon human perception and only then turns to physical measurement.

Acoustics — Soundscape —

Part 2:
Data collection and reporting requirements

1 Scope

This document specifies requirements and supporting information on data collection and reporting for soundscape studies, investigations and applications.

This document identifies and harmonizes the collection of data by which relevant information on the key components people, acoustic environment and context is obtained, measured and reported.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 532-1, *Acoustics — Methods for calculating loudness — Part 1: Zwicker method*

ISO 1996-1, *Acoustics — Description, measurement and assessment of environmental noise — Part 1: Basic quantities and assessment procedures*

ISO 12913-1, *Acoustics — Soundscape — Part 1: Definition and conceptual framework*

ITU-T P.58:2013, *Head and torso simulator for telephonometry*

ANSI/ASA S 3.36:2012, *Specification for a Manikin for Simulated in-situ Airborne Acoustic Measurements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12913-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
background sound
sound which is heard continuously or frequently enough to form a background against which other sounds are perceived

Note 1 to entry: Often these sounds are not consciously perceived, but they act as conditioning agents in the perception of *foreground sounds* (3.3).

3.2
descriptor
term which is used to describe the perception of any acoustic environment

3.3
foreground sound
sound to which attention of a listener is particularly directed and which can be associated with a specific source

3.4
indicator
term which is used to predict a *descriptor* (3.2) or a part thereof

3.5
local expert
person who is familiar with the area under scrutiny either living in the area or having further daily routines related to the area

3.6
noise
sound that is deemed to be unpleasant, unexpected, undesired or harmful

Note 1 to entry: Exceptions in this document are cases where the term "noise" is used as an established term, e.g. broad-band noise or environmental noise.

3.7
soundwalk
method that implies a walk in an area with a focus on listening to the acoustic environment

3.8
total sound
totally encompassing sound in a given situation at a given time, usually composed of sound from many sources near and far

[SOURCE: ISO 1996-1:2016, 3.4.1, modified — The figure and notes have been deleted.]

4 Descriptors and indicators

4.1 General

It is central to soundscape research, studies and implementation to fit descriptors and indicators to the perception and the assessment of the concerned people. Classical indicators are known to show strong limitations under certain sound conditions (low frequency sound, tonal components, multi-source environments). The choice of indicators depends on the type of the investigated soundscape. It is important that the fit of indicators reflects the situation and context (personal, social, cultural, land use, economic, geographic) which define the acoustic environment, and also enables tracing dynamic changes like time variances of the soundscape over the day or season.

Soundscape studies shall always consider the key components: people, acoustic environment and context (see definitions and explanations in ISO 12913-1):

a) **people:**

- the participants shall be classified according to Annexes A and E;
- self-reported views of the participants (on the acoustic environment and on the context) shall be obtained via questionnaires and/or interviews (see Annex C);
- in certain cases, if determined appropriate by the investigator or researcher, data collection via non-participatory observations shall be obtained; this can include, for example, data collection of subject(s)' walking speed, proximity and/or openness to others (e.g. those not known to themselves), head movements, and occupation time (e.g. time spent in the observation area) [39][40].

NOTE It is recognized that there are current limitations in feasible techniques. There can be difficulties in trying to capture customary and holistic human response, by putting people into survey contexts which can change their listening and related states.

b) **acoustic environment:**

— it shall be reported whether a real, recorded or virtual environment (indoor or outdoor) is considered and whether it is a laboratory or field study (see Annex A);

— sound sources shall be described following a sound source taxonomy (e.g. Annex C);

— the acoustic environment shall be described using a combination of appropriate acoustic indicators (e.g. see ISO 1996-1) and psychoacoustic indicators (see Annex B).

c) **context:**

— information on the context shall be reported in detail in accordance with Annex A.

This document specifies the data collection and reporting method(s) for each of these key components in turn. The annexes provide further details of recommended (and any alternative) approaches for each component.

The main requirements and some of the associated questions for descriptors and indicators shall support:

— acoustical assessment: acoustic distinction of the variety of soundscapes (Why does this place sound different? What is unique?);

— psycho-physiological assessment: assessment of the grade and type of neurophysiologic stimulation (Is the soundscape stressing, supporting or relaxing? Which emotions are linked to it?);

— context assessment: assessment of the person-environment fit [Are there sounds or sound components that interfere with the intentions/expectations of the meaning or support these? Are there other sensory factors (visual, vibration, olfactory) that interact with the sounds in a supporting or distorting way? Is the meaning of this place or the attachment to this place distorted, undermined or supported?];

— design or remedial action: assessment of the holistic potential of the place (Are control/coping options available/implementable? Can new meaning/emotions/attachment and social interaction be created to support adaptation and meet expectations?).

4.2 Acoustic and psychoacoustic indicators

In order to describe the acoustic environment as the sound from all sound sources modified by the environment and auditory sensations evoked by the sound, a set of acoustic and psychoacoustic indicators shall be measured and reported as a minimum. Classical acoustic indicators shall be measured and reported to be in conformance with ISO 1996-1. This includes equivalent continuous sound pressure level $L_{\mathrm{Aeq},T}$ and $L_{\mathrm{Ceq},T}$ as well as percentage exceedance levels $L_{\mathrm{AF5},T}$ and $L_{\mathrm{AF95},T}$.

Psychoacoustic parameters play an important role with respect to auditory sensations. Such parameters are functions of the time structure and spectral distribution and lead to results which yield information with greater differentiation than the consideration of the sound pressure alone. Psychoacoustic loudness indicators shall be reported in conformance with ISO 532-1, since acoustic environments are time-variant sounds.

The consideration of further psychoacoustic parameters, like sharpness, tonality, roughness and fluctuation strength, is recommended. If calculated and reported, the used calculation method shall be reported. Some standards exist that can be applied to determine further psychoacoustic indicators, such as DIN 45692[6] for sharpness calculation or ECMA-74[7] for quantifying the tonality of discrete tones.

In general, the application of psychoacoustic parameters allows for an enhanced description of acoustical environments (see Annex B). It has been shown that psychoacoustic parameters, like

loudness and sharpness, correlate with the perception and assessment of environmental noise sources, e.g. road traffic noise[25]. However, acoustic and psychoacoustic indicators describe only the sound and evoked auditory sensations; for example, whether the sound is perceived as loud, sharp or tonal. These indicators are not intended to explain the level of pleasantness or appropriateness of sound in its entirety.

5 Data collection

5.1 General

In practice there is still a significant gap between soundscape descriptors and indicators, which are used in some standardized way in the "measurement by persons" and those applied in the "measurement by instruments". Psychoacoustic, ecological and landscape acoustics require techniques to be more tightly integrated in such studies to mediate between personal experience and group-area-society requirements and needs. Only through the proper integration of these techniques can the potential of the soundscape approach be implemented in planning and design. The soundscape approach relies by definition on this strategy. In this strict sense it can be said that any study that does not consider people, acoustic environment and context in a combination of several differing investigative methods cannot be seen as a full-featured soundscape study. So it is necessary to investigate each soundscape situation from several viewpoints. This requires performing a soundwalk (see 5.2) and/or a questionnaire (see 5.3) and/or a guided interview (see 5.4) in addition to the binaural measurements (see 5.6).

Soundscape data collection tools and methods can be applied in situ and in situations where sound is reproduced by headphones or loudspeakers. In the case of the reproduction of sound (e.g. for the performance of listening experiments) an appropriate test design shall be applied.

5.2 Soundwalk

Over the past few decades, the focus of soundwalks has shifted from noting the researcher's view to determining the people's understanding of places. The experiences and expectations of people, when they are listening and observing during a soundwalk, are accessed primarily through the evaluation of the rating scales and the annotation of the participants' comments.

Soundwalk is a method to obtain human sensations/responses/outcomes (see ISO 12913-1). Soundwalks are participatory group sound and listening walks through the environment. Soundscape analysts observe and measure the perceptual responses of the participants to the acoustical, visual, aesthetic, geographic, social and cultural differences. The participation of local experts and members of relevant communities of interest in soundwalks enables researchers, practitioners, policy makers and local authorities to collect and analyse ecologically valid acoustical as well as perceptual data. This enhances the investigator's sensitivity to the unique features of the examined areas.

Human sensations, responses and outcomes cannot be easily reduced to singular values of physical units. The response to sound depends on the listener's mental, social and geographical relation with the sound source.

5.3 Questionnaire

When gathering data on human perception, the investigator should not interfere with the participants' experience. Such data collection shall capture the general mood, restoration, appreciation, preferences and overt behaviour to create an accurate representation of a specific location. Moreover, this type of evaluation shall respect the way people are experiencing their environment. Data gathering via questioning participants is a possible way to assess the whole path from acoustic environment to soundscape, including the processes of individuals assessing and giving meaning to sound(s) and/or demonstrating their responses to the acoustic environment. The final assessment shall be holistic, covering all auditory sensations as well as all other context variables such as visual stimuli and personal expectations.

5.4 Guided interview

Data collection on human perception puts very strict requirements on managing attention processes. Guided interviews shall be performed with the respective participants to explore associations, feelings and emotions concerning the acoustic environment more deeply. The soundscape investigation demands a holistic approach for the analysis of environments. This is why perceptual data (interviews, questionnaires, non-participatory methods), psychoacoustic indicators (e.g. loudness, roughness, sharpness) and physical parameters (sound levels) shall be used. Moreover, perceptual data collection is particularly constructive because the context and information content of a soundscape can be assessed as a result. It is important to use guidelines for narrative interviews to guarantee compatible data collection related to the participant's individual perception. Currently guidelines are available in different formats. An example is provided in C.3.3.

5.5 Sound source taxonomy

To assist in source reporting for researches, a classification for all sound sources in any acoustic environment in accordance with a common framework or checklist, is recommended[17], see Figure C.1. The taxonomy shown in C.1 has been constructed on three levels: types of places, types of sound sources and sound sources.

Categories of places are broadly considered either indoor or outdoor; within the outdoor environment, they are divided between urban, rural and wilderness conditions. One can thus refer, for example, to the acoustic environment of a wilderness place, or the acoustic environment of an urban place. Having broadly characterized the type of the place, the taxonomy then categorises all sources of sound that can be present. Most importantly, the nomenclature of sound sources has been carefully chosen to avoid value judgements or connotations regarding these sound sources, irrespective of the type of the place (for example, "motorized transport" is preferred to "intruding traffic noise" or "the passage of lorries"). In some places, various sounds of human activities, say footsteps, can be present with only infrequent sounds from roadway traffic; but in another location, roadway traffic can constitute the only sound source. In each of these examples, the taxonomy of sources is applicable and encourages the description of sources using a common terminology. The distinctiveness of particular acoustic environments lies, amongst other things, in the presence or absence of these different sources and their relative intensities. However, the framework for sound source identification assists in comparing the reporting of sound sources across places and make other labels, value judgements and definitions more transparent, and thus portable, across different studies.

5.6 Binaural measurements

Acoustical measurements related to a soundscape shall consider the way human beings perceive the acoustic environment. For this purpose calibrated binaural measurement systems (artificial head) shall be used to record an acoustic environment. Measurement conditions shall be chosen to measure the acoustic environment as close as possible to the human auditory sensation. Binaural acoustical measurements shall be performed in accordance with Annex D.

Each binaural measurement shall be described in a soundscape binaural measurement protocol. The measurement protocol includes information about measurement time and interval, description of measurement locations, measurement equipment, atmospheric conditions, notation of the influence of topographical features, local shielding effects and description of sound sources. Reporting shall be made in accordance with Annex A.

NOTE Further recording technology such as microphone arrays are frequently used in soundscape investigations. It is acknowledged that those recording technologies can offer some advantages. In particular, such technologies strive for a latter playback based on multi-loudspeaker arrays providing a certain level of immersion. However, in contrast to binaural measurement technology these technological approaches lack standardization and make it difficult to perform aurally accurate analyses to compute psychoacoustic parameters and indicators.

Binaural recordings are used for aurally adequate analyses, for the reproduction of acoustic environments (e.g. in laboratory-based listening experiments) or for the purpose of preservation and archiving.

6 Reporting requirements

The minimum reporting requirements that shall be adopted are given in Annex A.

Annex A
(normative)

Minimum reporting requirements

A.1 General

The minimum reporting requirements in soundscape studies comprise the following:

a) the selection and classification of the participants;

b) a characterization of the studied acoustic environment;

c) the data collection with regard to human perception of the acoustic environment (including context).

A.2 Participants

Soundscape studies are primarily conducted as field studies. However, sometimes laboratory studies are also carried out. An example of a field study is a case study of a residential area where the acoustic environment is redeveloped. In such a case it is common to select residents as participants in order to learn how they perceive the acoustic environment and how they would like it to sound (indoors as well as outdoors). Other examples of field studies are evaluations of parks or green areas. In these cases it is common to select visitors in order to learn how they perceive the park and its acoustic environment. It is also possible to select a panel of participants who are brought to the field study site to evaluate its acoustic environment. Panels of participants are common in laboratory studies, which typically are used to assess audio recordings of the acoustic environment from one or several sites.

As in any study design, the participants shall be identified and the following information recorded:

a) how they were selected;

b) whether the participants were residents at or visitors to the study site;

c) whether the participants were lay people, or experts in a field that is relevant to the study (e.g. environmental noise or urban planning);

d) age and gender distribution;

e) other relevant information (e.g. hearing ability).

A.3 Acoustic environment

An acoustic environment can be real, recorded or virtual. A real acoustic environment is evaluated in situ by means of a field study. A recorded or virtual acoustic environment is evaluated in a laboratory.

The two most common recording techniques in soundscape studies are binaural and ambisonics. The former is typically reproduced by headphones and the latter by a multi-loudspeaker array. A virtual acoustic environment can be based on recorded or synthesized sound sources that are mixed together into an acoustic environment.

With regards to the characterization of the studied acoustic environment, the following aspects shall be reported:

a) what type of acoustic environment the study concerns (real, recorded or virtual);