

Towards some standardization in assessing soundscape preference

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ABSTRACT

Soundscapes involve diverse fields of practice, diverse approaches and diverse disciplinary interests. The field overlaps with the much larger and established field of environmental noise management, and also intersects, to various degrees, with other areas of acoustics such as sound quality, human acoustic comfort in buildings, and music—and also with non-acoustic fields such as wilderness and recreation management, urban and housing design, and landscape planning and management. Working Group 54 of ISO/TC 43/SC 1 has been formed with a remit of standardization for perceptual assessment of human sound preference (in outdoor space) using questionnaires. The Group has only recently begun its work, and with considerable discussion amongst its members of a wide range of issues—not least of which was an adequate definition of soundscapes. This paper makes a range of observations and suggestions on this work including the outcomes of interest, the role of context in assessment, various kinds of sound sources in different places, and lessons from questionnaire measurement of noise annoyance. It represents a personal view, though informed by a range of opinions from the Working Group meeting and from relevant literature.

1. THE OBJECTIVES AS DRAFTED

In 2008, a Working Group of ISO/TC 43/SC 1 was established to begin consideration of a standardized method for assessment of soundscape quality outdoors—such assessment being seen as not just a question of presence or absence of annoying sounds, but the

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positive aspects of sound environments as perceived by people. The proposal argued that such a standardized method could be utilized by researchers to achieve compatibility of results from various studies of relationships between perceived soundscape quality and acoustic, physical and visual properties of areas; by authorities in preparation of guidelines based on perceptual assessment of soundscape quality; and by city planners and others in investigation of soundscapes that could lead to creation of high quality soundscapes in recreational and residential areas.

Potential application could be in outdoor recreational areas (e.g. city parks, urban squares, or wilderness) and in residential areas of high sound quality (e.g. outdoor places, gardens, or balconies of buildings). Matters that could be considered for standardization included methodology, questionnaire protocols, identification of sounds heard as part of the soundscape, ratings of human overall preference and of various perceptual dimensions of the soundscape, together with essential information to be recorded on the setting and on human activity.

The Working Group (WG) held an initial meeting, early in 2009, in which its members, with a diverse range of interests in soundscapes (human perception studies, urban design, wilderness management, noise control, transport, tranquility assessment, etc) and a wide range of disciplinary backgrounds (acoustics, engineering, planning, architecture, design, park management, psychology, sound quality, sociology, geography etc) attempted to tackle some of the issues that might be involved in moving the Working Group's objectives forward.

It was not surprising that such a varied group struggled not only with diverse views, concepts and levels of understanding of soundscapes, but also with the purposes and intended outcomes of the WG. While there were some tentative agreements, much remains under debate, and in rather fundamental areas such as a working definition of soundscapes and the feasibility of using questionnaires to assess perception of soundscapes.

This paper is the authors' attempt to elaborate on some of the issues and principles that impact this topic. It is not an account of the proceedings or a majority view of the WG.

2. THE SOUNDSCAPE

A fundamental question that exercised the group was "What is the soundscape?" Some members sought a strict definition of the term whereas others would settle for a fuzzy definition for the time being, on the basis that a more precise one would evolve during future work of the group.

For some members, a soundscape is present in (among other things):

- A physical, mainly outdoor area/space/location ('place') that can be described by a set of physical parameters such as geographical coordinates, dimensions, topography.
- A 'place' that also exhibit certain visual properties such as 'landscape', 'nature', man-made constructions, as well as micro-climate conditions.
- A 'place' with certain acoustical properties that can be described by acoustical parameters such as type of sound sources, levels, spectrum, temporal pattern.
- A 'place' where people (and/or other living creatures) live or occasionally spend some time.

- A ‘place’ where people interact with the physical environment and with each other.

However, these observations are only partially helpful and it is useful to examine various terminologies in the soundscape literature.

A. The Entity under Study in Soundscapes

Different terms have been used in the literature to describe the entity under study in the soundscape field. Generally, authors have been quite clear within their particular contexts, but the diversity of terms, whether these terms mean different things or whether they are synonyms (or hypernyms or hyponyms), and their potential to lead to misunderstanding by others, is an unsatisfactory situation. Without attempting to elaborate here on the contexts in which they were used, the terms include: the acoustic environment [1]; the sonic environment [2]; the sound environment [3]; the environment of sound [4]; aural space [5]; the natural acoustic environment and environmental sounds; sound ambient environments [6]; ambient conditions [6]; quiet areas; areas where environmental noise quality is good [7]; areas of high acoustic quality [8]; city soundscape [9]; the total ambient acoustic environment [10]; the total soundscape [10] and the acoustic soundscape [11].

We suggest that an adequate and appropriate term for the entity on which soundscape studies focus is the *acoustic environment* (or less preferably *sonic environment*) of any place. We examine places, and taxonomy of sounds in those places, further in Section 4 below.

B. The Centrality of Perception

Central to nearly all uses of the term *soundscape* is emphasis on the way the acoustic environment is perceived and understood by the individual, or by a society [3, 4, 6, 12, 13, 14, 15, 16]. Thus a *soundscape* exists through *human perception of the acoustic environment*.

However, the soundscape term is also used to describe the physical environment before perception—for example “all the waveforms faithfully transmitted to our audio cortex” [17], or “...the sound variations in space and time...of the built-up city and its different sound sources”... [11]. There would appear to be no difficulty in continuing to utilize the term *soundscape* of a place to represent *both* “the acoustic environment as perceived by humans” [10] as well as “the total collection of sounds”—the physical phenomenon. However, the latter use needs to be restricted to where the identification or measurement of those sounds is by the ear, to avoid devaluation and misuse. The primary concern [18] here is the growing and uninformed use of *soundscape* as a synonym for *community noise* - a community noise survey, for example, becoming a soundscape survey; a map of urban noise being described as a soundscape map.

Various authors have also drawn the useful analogy of soundscape as the auditory equivalent to (visual) landscape [1, 6, 15, 19]. The landscape can be, as can the soundscape, both a perceptual construct and a physical phenomenon [20, 21]. It is also recognized that the acoustic and the visual (and other) components interact in human perception of them [22].

This perceptual concept of the soundscape allows it to be applied not just to a place as it is experienced, but also to the soundscape of a place in memory [19] or even to abstract constructions such as musical compositions [2], or sound installations.

It can be noted that the centrality of human perception in the soundscape field has sometimes been described as a fundamental contrast between it and the environmental noise field. However, much work in noise is also perceptually based as in, for example, the measurement of annoyance. The real distinction between the two fields is in the nature of the outcomes of interest, as discussed in Section 4.

3. TOWARDS HUMAN ASSESSMENT OF THE SOUNDSCAPE OF A PLACE

Any analysis of human assessment of soundscape requires specification of:

- the outcomes of interest
- the role of context in assessments.

A. Preference for What Outcome?

The literature shows the study of the soundscape to have a variety of objectives. It may be studied intrinsically, examining the systematic relationship between humans and the acoustic environment (*soundscape ecology* [4]) but much work has to do with soundscape quality, human preference for different soundscapes, or human acoustic comfort [13]. Longer term objectives include the creation, or improvement, of the soundscape of a place (*soundscape design* [4]) or its management. Discussions of standardization of measurement of soundscape quality, or human soundscape preference, quickly lead the WG to deliberate on the question of “preference in terms of what outcomes”.

In different places and in different contexts, a person’s preferred outcome with respect to the acoustic environment may differ markedly. The preferred outcome could also be multidimensional. Table 1 lists a wide variety of outcomes that could potentially be associated with human soundscape assessment.

| | | |
|-----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| acceptability appropriateness clarity comfort <i>communication</i> enjoyment excitement happiness harmony | identification of place importance information liveliness naturalness <i>nature appreciation</i> nostalgic attachment peacefulness place attachment | relaxation safety satisfaction sense of control solitude tranquility uniqueness variety well-being |
|-----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|

Table 1. Different outcomes which might determine preference for the soundscape in different places and contexts. Most are examples of *direct outcomes*; those in italics examples of *indirect* or *enabled outcomes*.

For example, the soundscape of a place might be preferred on the basis that it is peaceful, or tranquil, or promotes well-being. Equally, in a different place or context, a soundscape might be preferred because it is lively, or varied, or creates a sense of excitement. Or preference may be for a soundscape that provides information, clarity, and conveys safety. In yet another place or context, preference for a soundscape may relate to

its unique cultural or natural characteristics (a place with soundmarks [2]). Those working in particular fields may have a very clear idea, or mandate, regarding particular outcomes—say in national parks, recreation or wilderness areas—but these may not be equally appropriate for those working in other fields, say urban open spaces, or housing complexes. An approach to standardization of soundscape assessment should attempt to accommodate this diversity in outcomes—or alternatively clarify that particular assessments are appropriate only for certain outcomes or certain places. Table 1 is an initial list, illustrative rather than comprehensive, with no attempt at classification. This is an area in which further work is required including: identification of all outcomes of potential interest in soundscape studies; development of a typology of outcomes; intercorrelations between outcomes of different types and identification of any underlying structure of outcomes (by factor analysis or similar); and association of particular sets of outcomes with particular places/contexts.

The outcomes in Table 1 can be considered for the most part as *direct outcomes*. Measurement of preference for these is premised, to a large extent, on people being aware of the sounds around them—and consciously attributing the particular outcome directly to the soundscape. However the soundscape of a place may enable certain outcomes/activities without people consciously dissecting why it is that the environment of a place provides so well for that activity. For example, people may know that a place is a good one in which to play with children, or in which to relax or meditate, or to meet with people, or communicate, or undertake other activities. They seek to achieve these outcomes in places—facilitated by the soundscape, along with other dimensions of the place—but not necessarily with conscious attention to the soundscape itself. This poses a significant methodological problem for soundscape assessment by introducing an “experimenter effect”, amongst other things, where measurement of people’s preference in these situations using questionnaire methods requires first drawing their attention to something on which they may have never consciously reflected. Assessment of soundscapes should recognize the existence of both *direct outcomes* (outcomes provided directly by the soundscape) and *enabled outcomes* (outcomes that are enabled or facilitated by the soundscape). There appears little work to date in soundscape assessment that has canvassed this distinction, and the latter may require study methodologies other than questionnaire approaches—behavioral studies, perhaps, where the locational choices of people undertaking certain activities are correlated with the soundscape. There is already some evidence that people’s choices in using an urban square are related to soundscape elements [3]. Standardization of assessment approaches should recognize the existence of both direct and enabled outcomes.

B. Context

The discussion so far has emphasized that soundscape preference depends critically on context. Pertinent contexts in soundscape assessment comprise at least the following:

- Place/location including the landscape, built form, and other aspects of the setting. What is preferred in one place will be different to what is preferred in another, and even in one place at different times of a day, week or season.
- Dimensions of the physical environment including factors such as wind, temperature, lighting, traffic.

- Personal activity in the place (alone or in company) and the activities of others in the place.
- Dimensions of the social environment including neighborhood/area characteristics and societal norms with respect to place, activity, and behavior.
- Personal dimensions. These will include *immediate* matters such as motivation for being in a place and undertaking an activity, and *longer-term* attributes individuals may carry with them:
 - chronic exposure to sound at home or work,
 - expectations of a place—a person may have expectations of organ music, not rock, in a church; or particular attitudes to amplified music in public spaces. While some of these dimensions may be variable, others may be fixed characteristics of the individual (compare the concept of *noise sensitivity* in noise annoyance studies).
- Consideration of context also needs to be cognizant of attributes/characteristics, not just of those present in any particular space, but also of those who could utilize the place, or who may already have self-excluded themselves from the place, as the soundscape changes—a concept related to that of Recreation Opportunity Spectrum in recreation studies.

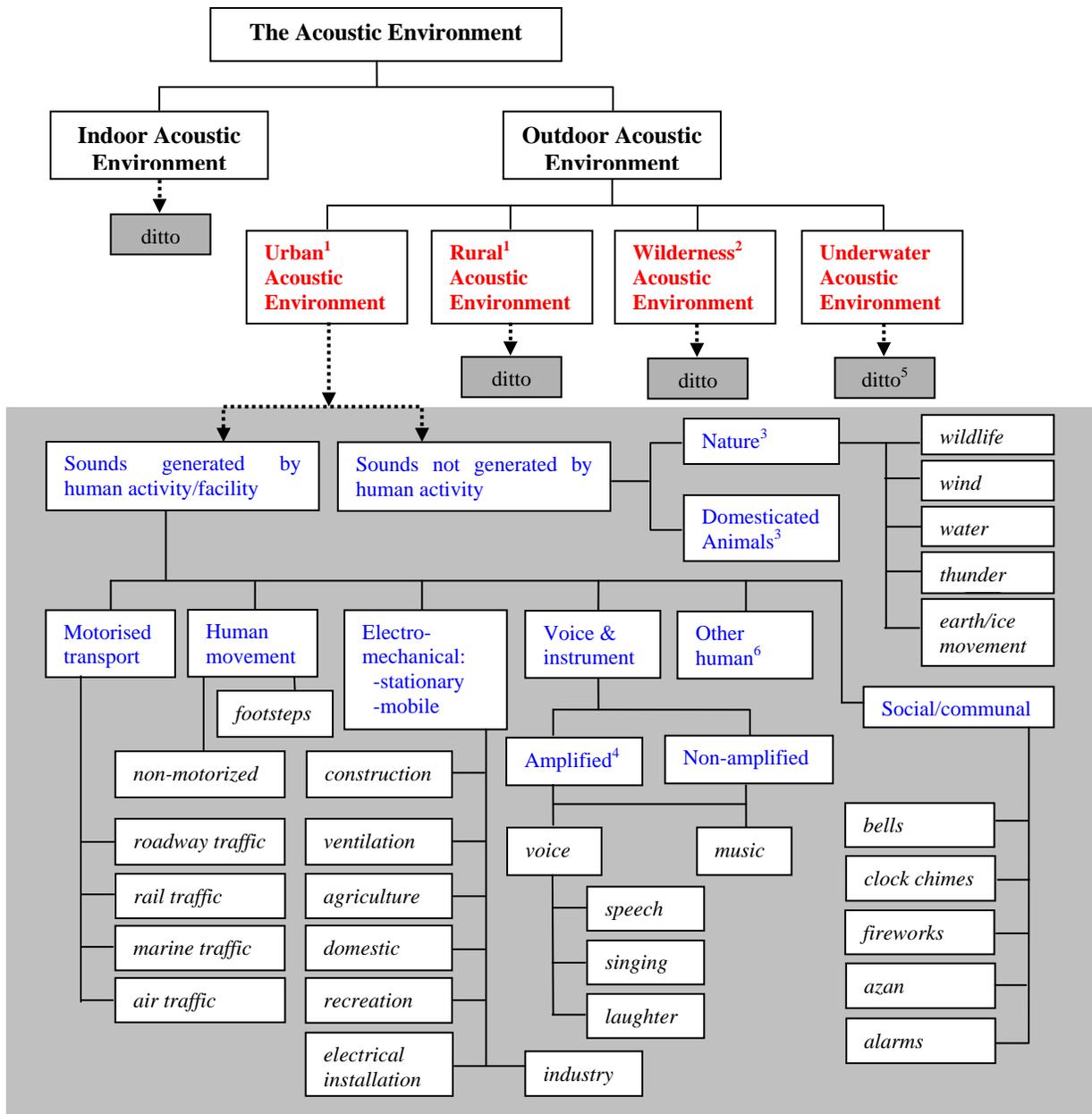
Standardization in soundscape assessment will require further analysis and identification of the contexts that are influential in determining preference, and specification of minimum requirements for their reporting in soundscape studies. Initial guidance on potentially relevant contexts can be found in the literature on perception [e.g. 23] in the landscape, environment and aesthetics fields.

4. PLACES AND SOUND SOURCES

Much soundscape work has focused on particular acoustic environments (natural areas or city squares, for example) identifying and describing the sources of sounds present in those places, and interpreting these as perceived soundscapes. When one looks across all types of studies—and even more broadly across both of the soundscape and environmental noise literatures—labels, descriptors and values have not been applied in a uniform way to the sources of sound in different acoustic environments. For example, the same sound source may be described quite differently—*background* in one place but *foreground* in another—and quite different values imputed to it—*intrusive* in one place but *acceptable* in another. This variability in terminology is a reflection, quite reasonably, of the role of context. However, as sound source identification has always to be an initial part of any soundscape work, transportability of sound source information is an important aspect of standardization in soundscape reporting and assessment—and ambiguity across different types of places its impediment. The problem is that the *presence and nature* of sound sources, and *human values associated with particular sounds* in particular places, are currently intertwined in much soundscape reporting.

As a basis for standardization in source reporting, we put forward a classification for all sound sources in any acoustic environment—a common framework, or checklist, for broad identification of sources.

Figure 1 is a possible taxonomy of the acoustic environment. It has been constructed in terms of categories of *places*—indoor, outdoor—and within the outdoor environment:



Footnotes:

¹ The urban/rural distinction will not always be readily defined, but remains useful.

² The wilderness category includes national parks, undeveloped natural and coastal zones, large recreation areas etc, and the wilderness/rural divide will not always be clear cut.

³ While “nature” and “domesticated animals” sources are shown as being “not generated by human activity” there are many areas of overlap—for example the sounds of running water in constructed water features or the sounds of wind on buildings. Domesticated animal sounds will generally be from animals associated with a human activity/facility.

⁴ Recording, replay, and amplification may occur for any type of sound—as for example in installations playing nature/wildlife sounds.

⁵ Because of the different acoustic impedances in air and water, many of the terrestrial sound sources within the shaded area of the figure would not normally be observed under water, but overall the same classification system is still applicable.

⁶ Coughing, for example.

Figure 1. A taxonomy of the acoustic environment for soundscape studies showing **categories of places**, **categories of sound sources**, and **sound sources**.

urban, rural, wilderness and underwater. While human experience of the underwater acoustic environment may be limited, its soundscape is increasingly being revealed through underwater recordings, or by the use of real-time transducers in, for example, whale-watching activities. 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 type of place, the taxonomy then categorizes all sources of sound that *could* be present. We have developed this set of sound sources on two criteria. Firstly, it can be applied in all types of acoustic environments and places. Secondly, the nomenclature of sound sources has been carefully chosen to avoid value judgments, or connotations, regarding these sound sources, irrespective of the type of place. The taxonomy builds on previous categorizations, such as that of the urban soundscape [6] but is designed to be universal in its application.

For example, a wilderness acoustic environment will consist largely of sounds not generated by human activity—the sounds of nature—but there could also be some human-generated sounds: aircraft, the speech or laughter of recreationists, and perhaps the amplified speech from the radios used by rangers. In the courtyard of a housing estate, sounds generated by nature may be incidental, and those generated by human activity will be present. In some places, various sounds of human activity, say footsteps, may be present, with only infrequent sound from roadway traffic, but in another, roadway traffic may constitute the only sound source. In each of these examples, the universal taxonomy of sources is applicable, and encourages description of sources using a common terminology.

Of course the distinctiveness of particular acoustic environments lies, amongst other things, in the presence or absence of these different sources and their relative intensities. However, a universal framework for sound source identification should assist in comparing the reporting of sound sources across places, and make other labels, value judgments, and definitions more transparent, and thus portable, across different studies.

The taxonomy of Figure 1 is appropriate to describe the sources present in an acoustic environment irrespective of whether as part of a soundscape study or as part of an environmental noise study. The primary distinction between these types of studies is not the sources of sound, nor the levels of the sounds (though these will generally be critical) but the *human outcomes* that are of particular interest. Almost exclusively, the environmental noise field examines the acoustic environment where the sounds present produce adverse outcomes for people. By contrast, soundscape studies examine the acoustic environment primarily where the sounds present produce outcomes that enhance, enable, or facilitate, human enjoyment, health, well-being or activity.

5. LESSONS FROM QUESTIONNAIRE MEASUREMENT OF ANNOYANCE

A method for measuring residential noise annoyance by means of socio-acoustic surveys is specified in ISO/TS 15666:2003 [24]. This specification is widely used in research on the relationship between noise annoyance and residential noise exposure. The brief for the current WG was motivated, in part, by the notion that there could be a corresponding specification of method for measuring human preference in soundscape studies. For example, a questionnaire protocol and a method for reporting soundscape results has been developed in a Swedish research program based on empirical studies in residential areas and city parks [25, 26]. We note however that there are significant situational differences

between annoyance and soundscape preference measurement (Table 2) that will need to be considered in the process of moving towards standardization in the latter.

| Annoyance Measurement | Soundscape Preference Measurement |
|-----------------------------------------------------------------------|-------------------------------------------------------------|
| single outcome (annoyance) | many outcomes |
| indoor (sometimes outdoor) at home | many different places |
| home activities disturbed by external noise | many different activities |
| live in that location | may be temporarily in that location |
| assumes respondents aggregate their annoyance over an extended period | unspecified assumptions regarding aggregation of perception |
| usually high level of sound | range of levels of sound |
| sounds usually (though not exclusively) from transport sources | many different sound sources |

Table 2. Situational differences between *annoyance measurement* and *soundscape preference measurement*.

Quite apart from issues raised by such differences, there are lessons from the experience of standardization in annoyance assessment by the ICBEN (The International Commission on the Biological Effects of Noise) team on Community Response to Noise [27]. The push for standardization arose from annoyance work being plagued by the use of different outcomes, different annoyance scales, and different or underreporting of contextual matters (modifiers or confounders). Meta-analysis was significantly impeded by these issues. Secondly, extensive cross-cultural and cross-language studies were necessary to arrive at the standardization in ISO/TS 15666:2003 [28].

For example, the standard comprises two questions on annoyance and the questions have been translated into different languages (eleven to date) using a detailed procedure for translations and back-translations to make sure that the original meaning has been kept intact. The corresponding scales for the responses included a verbal scale and a numeric scale, with the verbal scale constructed according to a detailed protocol to ensure that the commonly understood meaning of a word is consistent with its position on the scale. The scales in different languages are not mere translations, but have been constructed individually for each language using the same protocol. Soundscape preference measurement will need to adopt similar approaches to achieve international standardization.

6. CONCLUSIONS

For standardization, there is a need to develop a common language of concepts and terms regarding the outdoor acoustic environment that can provide a foundation for communication across different academic disciplines and across different professional areas with an interest in soundscapes. This paper makes a range of observations and suggestions to this end including:

- An adequate term for the entity on which soundscape studies focus is the *acoustic environment* (or less preferably *sonic environment*) of any place.
- A *soundscape* exists through human perception of the acoustic environment, but it is appropriate to utilize the term *soundscape* of a place to represent both “the acoustic environment as perceived by humans” as well as “the total

collection of sounds” of a place. The latter use needs to be restricted to identification or measurement of those sounds by the ear, to avoid devaluation and misuse of the term.

- In different places and in different contexts, people’s preferred outcome in terms of the acoustic environment will be highly varied. The initial aim of any standardization of soundscape assessment approaches must be to accommodate these full range of outcomes, or alternatively clarify that particular assessment approaches are appropriate only for certain outcomes or places. Further analysis and specification is required of:
 - preferred outcomes in different places and contexts
 - correlation between different outcomes
 - direct and indirect (enabled) outcomes.
- The need for identification, analysis and categorization of contexts pertinent to soundscape studies, and specification of minimum requirements for their reporting.
- A generic classification of sound sources for any acoustic environment intended to be independent of place and free of value judgments, or connotations, regarding these sound sources. Sound source identification has always to be an initial stage in any soundscape work and the taxonomy suggested should assist in comparing sound sources across places, and make labels, value judgments, and different definitions more transparent, and thus portable, across different studies.
- Clarification of the relationship between soundscape studies and environmental noise annoyance studies in terms of different outcomes of interest.
- Learning from past approaches to standardization of the measurement and reporting in noise annoyance studies, including cross-cultural and cross-language standardization
- The need to consider a range of methodologies for soundscape assessment, including, but not limited to, questionnaire assessments. These have been touched upon only briefly in this paper.

ACKNOWLEDGEMENTS

The assistance of Helen Lin in preparation of this paper is gratefully acknowledged. The contribution, through lively discussion, by members present at the first meeting of WG54, is also acknowledged.

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