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# Exploring Our Sonic Environment Through Soundscape Research & Theory

*How can we know what people think of their sonic environment? Well, we ask them!*



## Introduction

The soundscape concept was first introduced as an approach to rethink the evaluation of "noise" and its effects on the quality of life. Now it has evolved into something much more. Soundscape suggests exploring all of the sound in an environment in its complexity, ambivalence, meaning, and context. Basically, the soundscape concept considers the conditions and purposes of its production and perception. Consequently, it is necessary to understand that the evaluation of noise / sound is a holistic approach.

This is why soundscape research represents a paradigm shift in the field of environmental sound evaluation. Moreover, it firstly relies upon human perception and then turns to physical measurement. The soundscape technique uses a variety of investigation techniques, taxonomy, and measurement methods, soundwalks, questionnaires, interviews and recordings (Schafer, 1977). This is a necessary protocol to approach a subject or phenomenon, to improve the validity of the research or design outcome and to avoid systematic errors by relying only on one approach.

The soundscape approach enhances the use of available resources through adding the human capital: the "local expertise" of the particular environment's inhabitants.

*Figure 1 :* *Typical urban public space for soundscape studies. Alexanderplatz, Berlin (2011)*

This it is why it is of primary importance that physical noise criteria match perceptive descriptors with perception being the leading factor. As a result, we can better match the inhabitants' needs and desires with an implemented design scheme. For example, in the community noise field, we can correlate complaints of people living in a certain place with metrics for policy. In the architectural design field, we can create a built environment which aligns the designer's aesthetic vision and the users' comfort, effectiveness and sense of well-being. This process also has its parallels in the field of sound recording and musical composition. Concerning interdisciplinarity, the methods of psychology and sociology, to engineering and design analyses are introduced to guarantee the combination of perceptual and physical tools for the planning of a multitude of land uses and building structures.

## Background

Soundscape studies have a rich tradition. The term as we use it today was introduced by R. Murray Schafer in 1977. Since then, this idea has been the subject of much research and application. A description of the work in progress up to now was presented in *Acoustics Today* (Schulte-Fortkamp et al. 2007), and in special issues in Soundscape (Schulte-Fortkamp and Dubois 2006) and the *Journal of the Acoustical Society of America* (Schulte-Fortkamp and Kang 2013).

Because the soundscape field has evolved differently around the world, as well as across disciplines, there is a diversity of opinions about its definition and aims. Consequently, the use of the term 'soundscape' has become idiosyncratic and ambiguous. The International Standard ISO/DIS 12913-1 (2013). aims to enable a broad international consensus on the definition of 'soundscape,' to provide a foundation for communication across disciplines and professions with an interest in soundscape (Brown, et al., 2011). The standard distin-

guishes the perceptual construct (soundscape) from the physical phenomenon (acoustic environment), and clarifies that soundscape exists through human perception of the acoustic environment. For the purpose of the International Standard, soundscape will be understood as a perceptual construct that is related to a physical phenomenon.

## Current Status

Soundscape research represents a paradigm shift as it firstly counts on human and social sciences (e.g. psychology, sociology, architecture, anthropology, medicine) and then on physics, but also takes into account the diversity of soundscapes across countries and cultures. Governments have sponsored much of the recent soundscape research. So, given the simple objective to reduce the noise level (the main focus, for example of the European Union (EU) environmental noise policy) it was found that the Environmental Noise Directive (2002/49/EC) does not necessarily lead to improved quality of life in urban/rural areas. Thus, a new multidisciplinary approach is essential as provided through the EU COST (European Cooperation in Science and Technology) Action TD0804 on Soundscape of European Cities and Landscapes, which includes 52 participants from 23 countries participating in COST, including 10 participants from outside Europe. As an outcome of this action a practical guidance in soundscape research is available (Kang, et al., 2013).

## Collaborations

There have also been collaborations with soundscape researchers in other networks, such as the Global Sustainable Soundscape Network (GSSN)www.greener-cities.eu. funded by the USA National Science Foundation, further COST Actions, and a number of EU projects including the "Holistic and Sustainable Abatement of Noise by optimized combinations of Natural and Artificial means" (HOSSANA)www.greener-cities.eu. and the urban sound planning project SONORUS-www.fp7.sonorus, further EU networks such as European Network on Noise and Health (ENNAH)www.ennah.eu.

## What is central to soundscape research focused on noise and its perception?

While classical noise indicators are known to show strong limitations under certain sound conditions (low frequency noise, tonal components, multisource environments), it is central to soundscape research and implementation to fit the applied indicators to the perception and the appraisal of the concerned people. The fit of indicators also depends, however, on the type of investigated soundscape. It is extremely important that the fit of indicators reflects the situation and context (personal, social, cultural, land use, economic, geographic) which define the sonic listening space, and also enables tracing dynamic changes like time variances of the soundscape over the day or seasons *(Figure 1 - previous page).*

## Overarching main requirements and some of the associated questions for indicators should be:

- To support acoustical appraisal: Acoustic distinction of the variety of soundscapes (Why does this place sound different? What is unique?)
- To support psycho-physiological appraisal: Assess the grade and type of neurophysiologic stimulation (Is the soundscape stressing, supporting or relaxing? Which emotions are linked to it?)
- To support context appraisal: Assess the person-environment fit (Are there sounds or sound components which interfere with intentions / expectations / meaning or support these? Are there other sensory factors [visual, vibration, odors] which 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?)
- To support design or remedial action: Assessing 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?)

In practice there is still a significant gap between soundscape indicators which are used in some standardized way in "measurement by persons" and those applied in "measurement by instruments." For example, psychoacoustic, ecological and landscape acoustics need techniques to be more tightly integrated in such studies to mediate between personal experience and group-area-society requirements and needs. Moreover, only through proper integration of these techniques can the potential of the soundscape approach be implemented in planning and design.

Thus, the soundscape approach relies by definition on this strategy and in the strict sense it can be said: any study which does not use triangulation, that is, a combination of several differing investigative methods, cannot be considered a complete soundscape study. So we must look at each soundscape situation from several viewpoints to obtain a more complete picture of reality!
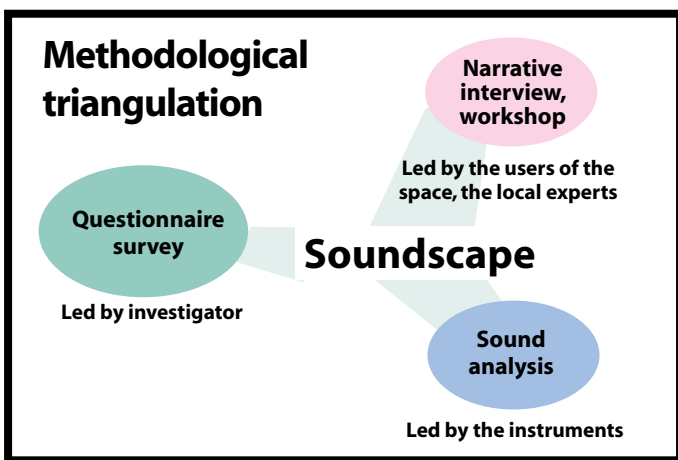


*Figure 2 :* *Basic triangulation model in soundscape research and practice (Lercher and Schulte-Fortkamp (2013)*

## Why Triangulation?
The concept of triangulation is borrowed from navigational and land surveying techniques that determine a single point in space with the convergence of measurements taken from

two other distinct points. The idea is that one can be more confident with a result if different methods lead to the same result. Accordingly, triangulation is a powerful technique that facilitates validation of data through cross verification from two or more sources *(Figure 2)*.  In particular, it refers to the application and combination of several research methodologies in the study of the same phenomenon *(Denzin, 2006; Jonsen and Jehn, 2009)*.

## Soundscape as a resource
Traffic noise sources *(Figure 3)* do not only cause annoyance, but also offer non-visual orientation in one's daily life. Subconscious routines reduce the effort of paying attention. To discuss the contribution of soundscape research in the area of community noise soundscape is understood as a resource, from which benefit is produced.

Typically, resources may be defined materials, money, services, staff, or other assets that are transformed to produce benefits to the interested parties, and in the process may be consumed or made unavailable. Benefits of resource utilization may include increased wealth, meeting needs or wants, proper functioning of a system, or enhanced well-being. From a human perspective a natural resource is anything obtained from the environment to satisfy human needs and wants.
Central to soundscape analysis is placing sound in a context, with noise and sound linked to activity at realistic study sites. The listener's sensational reality depends on the combination of their socio-cultural background and the psychological dimension with the acoustical setting. The acoustical socialization (acoustical biography) and action frame of reference of the concerned residents will also influence environmental noise evaluation. Therefore, tools for the exploration of the soundscape, microscopic as well as macroscopic, are needed. Clearly, the concept of sound as a resource reaches across a broad range of applications. For example, in architectural design, the introduction of artificial "noise," known as sound masking, can greatly improve the speech privacy, comfort, and effectiveness of workers in open-plan office environments.

**Figure 3 :** *Traffic noise sources, Broadway, New York City (2012)*

Similarly, in music composition and sound recording, the introduction of intense elements of volume or dissonance at the right moment can evoke the desired emotional response of the audience.

### Needs – What must soundscape researchers and theorists do going forward?

Beside the involvement of different disciplines, it is important to define areas of future research that will build the platform for further development. These include the areas of economics, noise policy-standards, and combined effects. Also vital is research into common protocols, cross cultural studies, education about soundscape, combined measurement procedures, the perception of the character of sounds, and cross cultural questionnaires. Moreover, the importance of survey site selection has to be emphasized, along with multi-sectorial environmental health impact assessment, the perspective on sustainable development environmental zoning, citizen involvement, and preservation of quiet areas.

This rather long list of vital influences on understanding the complete soundscape may seem daunting. However, these are all within the reach of today's scope of knowledge. These just need the continued attention of researchers to become effective tools for soundscape analysis. The benefit of developing these tools is the realization of high quality sonic environments that meet the needs and desires of their occupants. As we have learned from the Community Noise perspective, it is important to distinguish the totality of soundscape from the limited idea of a quiet zone. Consideration of "sensitive areas" and the design of "supportive environments" require new insights into the existing annoyance data and new integrative research strategies. There is a common consensus about the necessity of additional parameters beside the A-weighted sound pressure level which exists in an environment. Psychoacoustic parameters contribute immensely to efforts to measure and assess environmental sound more properly. Using psychoacoustic parameters, mainly based on standardized procedures of measurement and analysis, it will be possible to explain contributors of annoyance caused by environmental noise. As for the evaluation procedure, it is needed to integrate contextual and subjective variables, to ensure that soundscape is not just a matter of noise level reduction but also accounts for people's concerns and well-being.

Among qualitative methods there is a heterogeneous 'research landscape' which embodies different forms of observation, interviewing techniques with low level of standardization (such as open ended, unstructured interviews, partially or semi-structured interviews, guided or narrative interviews), and the collection of documents or archival data. Consequently, a host of methods are used, which rest on various theoretical and assumptions and methodological positions.

Yet, in spite of their differences, those approaches all share common ground, as advocates of the 'interpretive paradigm' agree on certain ideas about the nature of social reality, which is shaped by social meaning. So, for an environment's inhabitants, their perceived social reality is always a 'meaningful' reality. That is, the inhabitant thinks, consciously or subconsciously, "What does this feature of the environment mean to me?" A particular feature could have great impact, or none at all, on an individual. Similarities and differences in perception of the social reality among individuals may merge into a picture of consensus for a collective group of individuals. Due to the importance of meaning to the lives of these inhabitants, their social reality refers to a context of action which they observe in other people, and about which they may form judgments.  Social reality always depends on a certain point

of view or perspective and is therefore tied to social location. And lastly, since social reality is negotiated, it is always dynamic: social reality is a process. Clearly, this theoretical understanding of qualitative approaches will help to also understand what is meant by local expertise.

## Research guided through local expertise

Local experts are those people who live in the area under investigation and provide their expertise to researchers and project designers through such processes as soundwalks and open interviews (Voigt and Shulte-Fortkamp, 2012). Soundwalks are participatory group sound and listening walks through the environment. During these exercises, soundscape analysts observe and measure the perceptual responses of the participants to the acoustical, visual, aesthetic, geographic, social, and cultural modalities. Participation of local experts in soundwalks enables us, as researchers and practitioners, to collect and analyze acoustical as well as perceptive data. This enhances the investigator's sensitivity for the particularities of the examined areas. As the multidimensional human perception cannot be easily reduced to singular values of physical unit, such as A-weighted decibels *(Figure 4)* there is an imperative to obtain higher order layers of local expert descriptions, which provide a path to the meaning of sounds - and what quality may make them perceived as noise, or conversely as a desired, even treasured resource. This emphasizes the importance of recognizing the composition of multiple sound sources. Based on earlier findings, the response to sound depends on the listener's mental, social, and geographical relation with the sound source. Hiramatsu (2004) has proposed a method for comparing sonic environments on the basis of physical properties of and experiences and/or memories of sonic environments.



***Figure 4 :*** *Example of physical measurements of traffic sound – see instrument box and display on pole. Seocho-dong, Seoul (2009)*

## What are the inhabitants' expectations?

The attitude and the listener's expectations and experiences are significant parameters which may be used to comprehend the different perceptions and evaluations due to specific stimuli. People unconsciously gather the most important key features of the sonic environment, by experiencing this area in daily life. Mining these data on soundwalks and in interviews, and then combining them with the analysis of acoustical measurements via triangulation, sheds light on the phenomenon from different aspects.

## The soundwalk as an access tool to the sonic resource

The soundwalk, as one of the most important tools in the soundscape method, has variable procedures regarding the context, scientific issues, and approach (Fiebig et al. 2010). Over the past decades its focus has shifted from obtaining the researcher´s view to determining the people´s understanding of places. Mainly, the evaluation on rating scales and anno-

**Figure 5:** *Soundwalk with local experts, Berlin (2013)*

tating people's comments gains access to the experiences and expectations of the listening and observing attendee *(Figure 5).*

*For example,* the interview questions may relate to the people's agreement with a series of descriptions, on a verbal scale from "not-at-all" to "extremely."

Experiences include comparisons of similar and oppositional situations and show the time-grown development of the peoples' individual and collective mind (Voigt, 2013). They also refer to results of shifted strategies elaborated by previous decisions of acceptance and rejection of different soundscapes. This process of adjusting is described as "Passung" (Shulte-Fortkamp, 2010). That process considers all conscious and unconscious influences to the peoples' mind as they judge the appropriateness of sounds to sources, places, or situations.

Expectations of a known place imply a bandwidth of accepted occurrences which are often indicated by noticing the deviances. Descriptions and ratings of the situation, the location, occurrence, and sound sources, are the most common comments in the non-hierarchical, multiple layers of written reflections. Expanding the evaluation through situational discourse to an ad-hoc interview on the noted perception reveals additional layers of description.

In essence, data mining in the analysis of soundwalks goes beyond combining graphs vs. time with the notes of the attendees, and is already in process during data acquisition. The feedback given by the soundwalk participants after the original questioning enhances the analyst's insight into the meaning of sound to those local experts, and identifies how a particular sound may be perceived as a positive feature, or as noise.

## Considering moderators

Obviously, the soundscape approach and its methods enable us to learn about the process of perception and evaluation sufficiently as they take into account the context, ambience, the usual interaction between listener and sound, as well as the multidimensionality of sound perception. By contrast, conventional methods often reduce the complexity of reality to controllable variables, which supposedly represent the scrutinized object. Furthermore, traditional tests (2-AFC-method, A/B-comparison etc.) frequently neglect the context-dependency of human perception; they only provide artificial realities and diminish the complexity of perception to merely predetermined values, which do not completely correspond with perceptual authenticity. However, perception and evaluations entirely depend on the respective influences of the acoustic and non-acoustic moderators, as for example vegetation, neighborhood, and life-style.

## Application of soundscape analysis of local expertise to an outdoor public space

The development of the Nauener Platz in Berlin, a public place, is a pioneering example of how to collaborate in a soundscape approach with all project-relevant parties, or stakeholders. The Project "Nauener Platz - Remodelling for Young and Old" was conducted within the framework of the German government sponsored research program "Experimental Housing and Urban Development (ExWoSt)" of the "Federal Ministry of Transport, Building, and Urban Affairs (BMVBS)" by the "Federal Office for Building and Regional Planning (BBR)".

The key concept in the development of the outdoor public open place is the understanding that people living in the chosen area are the "real" experts concerning the evaluation of this place, according to their expectations and experiences of that place. Their knowledge is one of the most important investigative resources. The intention of the scientific research here is to learn about the meaning of the sounds and/or noise to those people, with respect to their living situation, and to implement adequate changes to effect an improvement of this place.



*Figure 6 : Scaling, Rating, Noting - Soundwalk, Berlin (2008)*

As the aim was to rebuild the place into one with social freedom, it was most relevant to involve those people who lived in the area from the very beginning *(Figure 6)*. Therefore, different approaches were carried out to get residents involved by, for example, public hearings about the intention of renovating the place and meeting with different social groups to determine their different expectations through well-defined workshops. Attention was given to participants' gender and age, and also to interdisciplinarity in collaboration among the researchers. "Sound walking" with all its evaluation features also provided the attendees of the several groups with a bonding quality to the development of "their" new place *(Figure 7)*. This was crucial to the acceptance of the installed features, reflected by the low very level of vandalism after the renovation. In 2012 this project was honored through the European Soundscape Award (www.eea.europa.eu).

In the scientific research project "Dynamic arrangement of urban safety cultures" – in the framework of the German "Federal Ministry of Education and Research" (BMBF) – the soundscape approach delivered new insights on the influence of acoustics toward the feeling of safety toward public places. Soundwalks and subsequent narrative interviews with professional security experts as well as local experts widened the field of understanding about modifying the quality of participant-declared unwanted sounds. The sonic characteristics of the unwanted sounds were traced to the occurrences and situations in those places, with the participants identifying on a subconscious level indicators which then demanded higher attention.

The process of "tuning" urban areas, based on the expertise of the people's mind to improve the quality of life, is strongly related to the strategy of triangulation (Schulte-Fortkamp, 2010).This provides the theoretical framework within which to develop the solution and actualize the needed change in an area. In other words: approaching the field in this holistic manner is a necessary component for success. An effective and sustainable reduction of the number of highly annoyed people caused by noise, and increasing the number of people greatly pleased, is only possible with further scientific endeavors in the area of methods development, and the research and application of sonic effects.

## Community noise implications

In the community noise field, noise level maps can start to provide an understanding of noise reactions and reliably identify perception-related hot spots. Psychoacoustic parameter maps are particularly interesting in areas where the noise levels

are marginal below the mandated noise level limits and offer an additional interpretation to identify the respective noise sources.

## What we have to think of when we talk about innovation through soundscape

In environmental health impact assessments (airports, rail tracks, roads) only the upper health limits of exposure are addressed. This leads to an attitude in government administration and policy to "fill up" the noise exposure to the maximum allowed.

Therefore, during the last 20 years noise exposure has spread from urban centers to suburban and rural areas and from day to nighttime - thereby reducing the viable options for restoration, undisturbed communication, while impairing public health and the environmental "quality of life."

Due to this unfavorable development recent strategy papers, guidelines and directives have stressed a change in noise policy and administration towards more perception oriented and sustainable assessments, including the protection of quiet and sensitive areas and times.

*For example:* it was the task of WG-3 of COST Action TD0804 to reconcile and integrate classical and soundscape oriented means ("harmonizing") and link those with quality of life and health related outcomes, in order to find appropriate strategies at different scales of assessment and implementation (Lercher and Schulte-Fortkamp, 2013).

There is still a lack of willingness and often ignorance among policy makers to use soundscape techniques in noise action plans and for the protection of quiet areas. Funding agencies still hesitate to fund soundscape projects.

The situation differs, however, broadly from country to country:
'Trying to do the right thing, play it straight, the right thing changes from state to state'
(Soul Asylum – Leave without a trace, 1992)

In order to take the full advantage of the benefits of the soundscape approach, it has to be accepted that:
- the involvement of different disciplines is needed to identify the resources in human and physical terms;
- soundscape research is the appropriate platform for further development in standards for improvement of the ecology and economy, as well as for noise policy-standards concerning the enhancement of quality of life;
- there is the need to link public Quality of Life and Health to Soundscape;
- there is the urgent need for the International Organization for Standardization (ISO) Working Group 54 of ISO / TC 43 / SC 1 to reach consensus on the soundscape definition standard ISO/DIS 12913-1, to provide the necessary stimulus for further worldwide progress.

## Architectural Design Implications

The soundscape methods described above may be easily transferred to the fields of architectural and urban design, for projects which include building interior and exterior spaces, site planning, urban and transportation planning, public parks, and more (Brambilla and Maffei, 2010). The soundscape method can be most effectively used to address acoustical concerns as early as possible in the architectural design process, even in the inspiration (vision) phase of a project.

Sonic perceptions of the built environment are often a vital part of the vision for a project, and must be expressed at the outset to be fully incorporated in the design. In this approach, design inputs are solicited from all stakeholders and design team members very early, before programming. Innovative project delivery methods and contract structures such as IPD (Integrated Project Delivery), unlike the traditional design-bid-build method, assign shared risk and reward among the design, construction and management teams. This offers great opportunities for practitioners, through soundscaping, to include acoustics in the initial project discussions, and to advance the implementation of quality sonic environments.

There is a striking congruency between architectural design and sound recording for music in the application of soundscape methods. How can the designer/composer ensure that their work will be successful? As Schafer said, "Orchestration is a musician's business. I am going to treat the world as a macrocosmic musical composition" (Schafer, 1977). To quote Cage, "Music is sounds, sound around us whether we are in or out of concert halls"(Warner and Cox, 2004). The answer to these questions is intriguing.

So many soundscapes – found, archived, preserved or composed – consist of multiple sound elements. The interaction among these individual sounds can conflict and obscure, or complement and harmonize. The creation of sound recordings through the multi-track production process offers a point of view into how an overall soundscape can be successfully created, and multiple sounds effectively orchestrated (Case, 2013). The parallels between the music production process and the architectural design process offer insights about how soundscape methods may help the composer/designer to create a meaningful "sense of place" within the listener.

## What's next?

The link between the fruits of soundscape research and their application to sonic environments which provide a sense of comfort and well-being is currently being developed. The focus of project soundscape designers is to establish consistent means to gain the stakeholder acceptance needed to implement these exciting, effective and creative tools.

The ultimate goal here is for the soundscape tool to be recognized as so powerful, so effective, and so influential that private developers, architects and urban planners will understand that they must use it, or risk the failure of their project. Perhaps too large a goal? We think not. The soundscape method is the logical and practical extension of an idea that was decades in the making, yet just now coming of age. There are many precedents to this approach in the built environment community, which are now coming to the fore. The timing is propitious and the benefits are enormous.
Stay Tuned!

## Biosketches

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