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The tuning of noise pollution with respect to the expertise of people's mind

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Abstract
Harmonization of indicators, noise mapping and action plans deliver basic administrative information not only for noise abatement in highly noise polluted areas but also for comparisons across European countries. However, such activities do not provide any tools or essential knowledge for more demanding tasks which are required for the design and planning of sustainable environments which are supportive to wellbeing and health.
Without the knowledge of the determining factors behind the dose-response curves the decision process for the development of "action plans" is narrowed down. Furthermore, optional courses of action to handle the noise problem cannot be sufficiently considered. Therefore, there is the need for an approach which involves diverse fields of practice and diverse interdisciplinary interests related to people's expertise in the respected areas. The multidimensional Soundscape approach puts emphasis on the way the acoustic environment is perceived and understood by the individual and by society (ISO/TC 43/SC 1/WG 54). The implementation of the Soundscape approach accounts for people's concerns and integrates the noise-exposed people as local experts.

Keywords: Soundscape, local experts, city planning, noise abatement, meaning of sounds, sound design

1 Introduction

In the original Soundscape approach, Schafer (1977) was worried about the dominance of the "visual culture" and the parallel loss of "sonological competence" in the modern societies. This concern let him develop a series of hearing exercises which aimed at maintaining a high level of sonic awareness. The interaction of people and sound, the way how people consciously perceive their environment were therefore central in his approach. His first field

studies (World Soundscape Project) involved level measurements (isobel maps), Soundscape recordings, and the description of a wide range of sonic features. 33 years later noise mapping is the major issue in noise control, and on the other hand the Soundscape approach is used in different areas in noise control and sound design in a wide range: from evaluation of a residential areas and amongst others to vehicle interior. Over the years, the Soundscape approach and its further development have been supported by countless research studies all over the world. Moreover, there is the European COST Action TD 0804 which creates a network among European "Soundscaping" by integrating Soundscape experts from all over the world. Also, the ISO/TC 43/SC 1/WG 54 has started to work on definitions which refer to evaluation procedures. (see paper by Schomer et al, Internoise 2010) With regard to application Soundscape is moving ahead in city planning and it's collaboration with the "local experts" and the "new" experts regarding sound design.

2 Why "Soundscape"

The Soundscape concept was introduced as a scope to rethink the evaluation of "noise" and its effects. The challenge was to consider the limits of acoustic measurements and to account for its cultural dimension introduced by Schafer's neologism and research. Soundscape suggests exploring noise in its complexity and its ambivalence and its approach towards sound to consider the conditions and purposes of its production, perception, and evaluation, to understand evaluation of noise/ sound as an holistic approach. To discuss the contribution of Soundscape research into the area of Community noise research means to focus on the meaning of sounds and its implicit assessments to contribute to the understanding that the evaluation through perceptual effects is a key issue.
Concerning physical measurements, there is a common consent about the necessity of additional parameters beside the A-weighted sound pressure level. Psychoacoustic parameters contribute immense to measure and assess environmental sound more properly. With the help of psychoacoustic parameters, mainly based on standardized procedures of measurement and analysis, it is possible to explain some contributors of annoyance but also acceptance caused by environmental noise. As for the evaluation procedure it is needed to integrate contextual and subjective variables to continually improve the Soundscape approach in accounting for people's expertise in the respective research fields.

The Soundscape approach requires that physical noise criteria match qualitative descriptors, to correlate complaint language with metrics for policy, and to introduce the qualitative methods of Psychology and Sociology to Engineering analysis, to combine quantitative and qualitative tools for land use planning. Analysis should place sound in context, with noise and sound linked to activity at realistic study sites. Besides the acoustical setting the listener sensational reality depends on the socio-cultural background and the psychological dimension. The acoustical socialization (acoustical biography) and action frame of reference of the concerned residents influence environmental noise evaluation as well. Tools for the exploration of the Soundscape, microscopic as well as macroscopic, are introduced.
Beside the involvement of different disciplines it is important to define areas that should built the platform in further development as economics, noise policy-standards, combined effects, common protocols, cross cultural studies, education about Soundscape, combined measurement procedures, qualitative and quantitative parameters-including the character of sounds and cross cultural questionnaires, and also the importance of survey site selection has to be emphasized. To wit, "in noise education, noise is taken as an objective entity, while in Soundscape education the sonic environment is constructed through listeners auditory and

other experiences which is the reflection of the concept of the deep Soundscape" (Hiramatsu et al, 2009) .

Further emphasis has to be given to multi-sectoral environmental health impact assessment, the perspective on sustainable development environmental zoning, citizen involvement, and to the p
reservation of quiet areas. Herewith, it is important to distinguish the totality of Soundscape from the limited idea of quiet zone. To consider the involvement in city planning, in "sensitive areas" and in the design of "supportive environments"require new insights into the existing annoyance data. The challenge is the integrative research strategy.

3

The "Sonic Environment" is a mediator between humans, their activities and the physical world. It has to be considered that sound
sources attribute "meanings" to the exposed and block or enable human activities, thoughts, feelings. Moreover, it depends on the "acoustic colouration" of the larger environment like geography, climate, wind, water, people, buildings, animals etc how people react to or deal with sounds.
That is why Soundscape evaluation should be dedicated to evaluate acoustical but also other sensory, aesthetic, geographic, social, psychological and cultural modalities in the context of human activity across space, time, and society. The questions have to be reformulated into scientifically questions addressed to the diversity of scientific domains and to overcome the sectoral barriers.
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4 Qualitative approaches – searching for the meaning

Using qualitative methods means, "we are referring to a heterogeneous 'field of research' (..) and among them are 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. At the same time, 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. Social reality is always a 'meaningful' reality, and by representing meaning , refers to a context of action in which actors organize action… social reality always depends on a certain point of view or perspective and is therefore tied to social location. And last, since social reality is negotiated, it is always dynamic: social realty is a process." (Hollstein, 2010)
Clearly, this theoretical understanding of qualitative approaches will help to also understand what is meant by local expertise. Local expertise in Soundscape is a combination of meaningful knowledge about an area referring to the context of interactivity or in Hollstein' s words a context of action in which actors organize action.
Considerably, local experts are those people in action that live in a certain area under scrutiny and provide their expertise e.g. through evaluation processes as sound walks and different kind of open interviews. Sound walks that are participatory sound and listening walks with respect to the acoustical, visual, aesthetic, geographic, social and cultural modalities. Participation of local experts in sound walks and their meaningful evaluation will give a focus for the analysis of the acoustical as well as qualitative data. To wit, these data enhance the investigator's sensitivity for the particularities of the examined areas.

Convincingly, there is no doubt that the multidimensional human perception cannot be easily reduced to singular numbers among others.
Based on earlier findings, that response to sound depends on the listener's mental, social and geographical relation with the sound source, Hiramatsu et al. have proposed a method for comparing sonic environments on the basis of physical properties of and experiences and/or memories of sonic environments. As an extension of this approach they developed the Environment Similarity Index (ESI) to judge differences and/or change in the quality of various environments.

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. Here, as much data as possible is collected from multiple sources as sound walks, interviews, acoustical and psycho acoustical measures to shed light on the phenomenon from different angles. (see also Hollstein 2010)

5 How the tuning of noise pollution works with respect to the expertise of people's mind

In earlier publications we introduced the development of the Nauener Platz in Berlin as one of the pathbreaking examples how to collaborate in a Soundscape approach integrating all relevant parties. the Project "Nauener Platz - Remodelling for Young and Old" belongs the framework of the 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)". It is related to the fields of research (ExWoSt) concerned with "Innovation of Urban Neighbourhoods for Families and the Elderly". The project executing organization is the Regional Office Berlin-Mitte.
The concept of development of the open pace relies on the understanding that people living in the chosen are the "real" experts concerning the evaluation of this place according to their expectations and experiences in the respective area. The intention of scientific research here is to learn about the meaning of the noise with respect to people's living situation and to implement the adequate procedure to open the "black box" of people's mind. Therefore the decision was done upon the combined quantitative and qualitative evaluation procedure in a Soundscape approach.
The concept of the development of the place was to rebuilt the place into one with social freedom and, from the very beginning to involve people who live in the area. Therefore, different approaches were done to get residents involved by e.g. public hearings about the intention other renewing of the place as well to get access to the different social groups with respect to their different expectations through well defined workshops. Also attention was given to gender and age, and on the other hand but also to interdisciplinarity in collaboration.

5.1. The concept of Interdisciplinarity in collaboration

Interdisciplinarity is considered as a must in the soundscape approach. In this case it was concerned with the collaboration of architects, acoustics engineers, environmental health specialists, psychologists, social scientists, and urban developers. The tasks are related to the local individual needs and are open to noise sensitive and other vulnerable groups. It is also concerned with cultural aspects and the relevance of natural soundscapes – sometimes

referred to as quiet areas – which is obviously related to the highest level of needs.

The Nauener Platz in Berlin is located between two main roads with a traffic volume of 18.444 cars/24 h in main road 1 and 14756/ 24h in main road 2. The following evaluation procedures were taken: measurements on sound propagation, traffic censuses, binaural measurements and qualitative evaluations through soundwalks and open interviews introducing the concept of local experts.

5.2 Selection of local experts

In a “public hearing” on the rebuilding of the chosen place people were introduced in the concept of evaluation through soundwalks and appointments with different groups, differentiated by age and gender were scheduled with 64 people respectively. Furthermore people were informed the need for narrative interviews. Those interviews have been scheduled with interested people by phone calls after they participated in the soundwalks.

5.3 Soundwalks, Measurements, Recordings, Interviews

Each evaluation with soundwalks was carried out in a group of at least 8 new experts.
The tasks were to define the listening position for the evaluation, to rank the road traffic noise using the Rohrmann scale, and comment on those rankings. Noise and comments were binaurally recorded. Based on the recommendations of the “local experts” while “sound walking” the marked eight points for subjective evaluation have been chosen for comments, rankings, and binaural measurements

At the same time the sound measurements for sound propagation calculations and binaural recordings were carried out. For few positions Figure 1 and 2 show the results concerning dB (A) while figure 3 and 4 give some information of the binaural recordings.

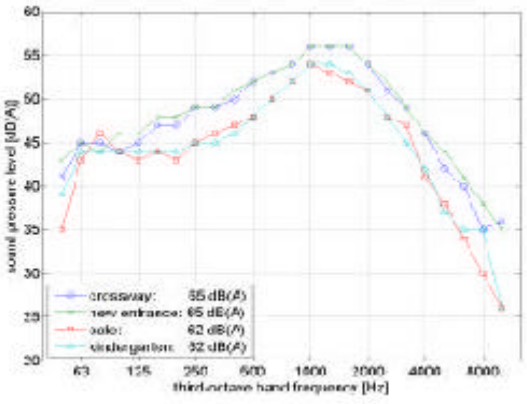


Figure 1: Results of the measurements
1/3-octave sound pressure levels , A-weighted

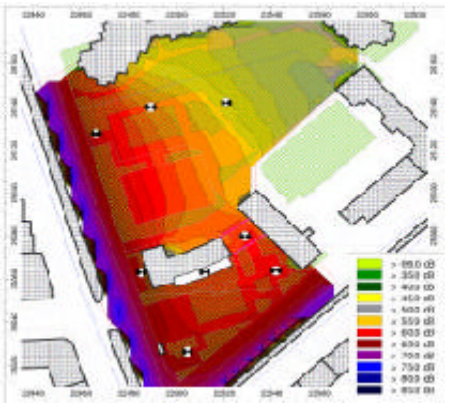


Figure 2: Calculated A-weighted
sound pressure levels

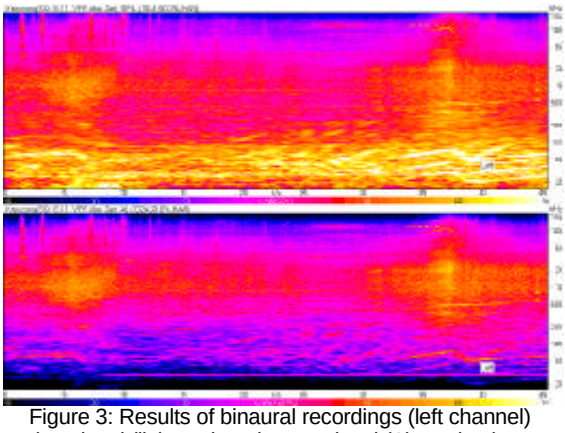


Figure 3: Results of binaural recordings (left channel)
(top: level (lin) vs. time; bottom: level (A) vs. time)

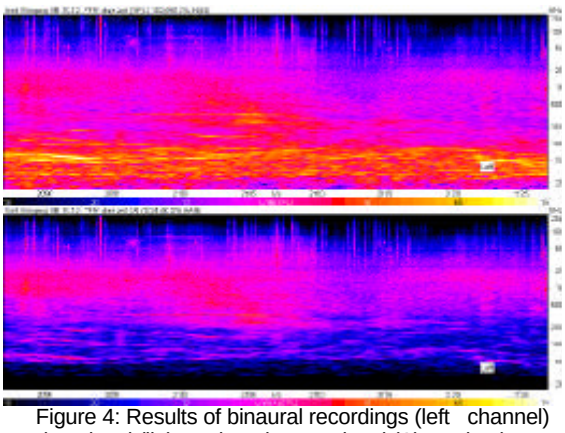


Figure 4: Results of binaural recordings (left channel)
(top: level (lin) vs. time; bottom: level (A) vs. time)

Obviously, these new approaches and methods make it possible to learn about the process of perception and evaluation sufficiently as they take into account the context, ambiance, the usual interaction between noise and listener and the multidimensionality of noise perception. By contrast, conventional methods often reduce the complexity of reality on controllable variables, which supposedly represent the scrutinized object. Furthermore, traditional tests neglect frequently the context-dependency of human perception; they only provide artificial realities and diminish the complexity of perception on 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 modifiers.

Following the comments and group discussion and also the results from the narrative interviews it could be defined why people prefer some places over the public place and why not. It also became clear how people experience the noise in the distance from the road and also with respect to social life and social control.
One of the most important findings here is how people react to low frequency noise at the public place and how experiences and expectations work together. It becomes obvious that the most wanted sound in this area is based on wishes to escape the road traffic noise through natural sounds.

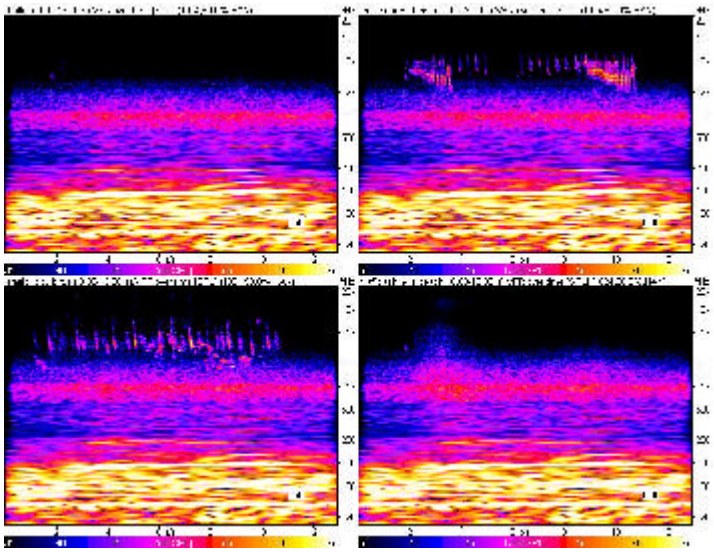
5.4 Reshaping the place based on people's expertise

Relying on the combined evaluation procedures the place was reshaped installing a gabion wall along one of the main roads and further more audio islands like have been built that integrated the sounds people would like to enjoy when using the place.
While the gabion wall protects against noise around the playground, the new installed audio islands developed by the landscape architect Barbara Willecke provide nature sounds as selected by the people involved in the Soundscape approach.

part of the gabion wall

model of the "Nauener Platz"

parts of the reshaped “Nauener Platz” - social reality

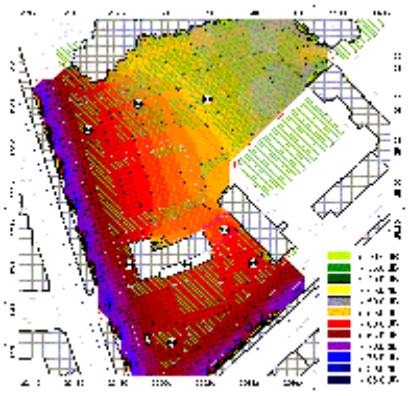


the sounds available in the audio islands

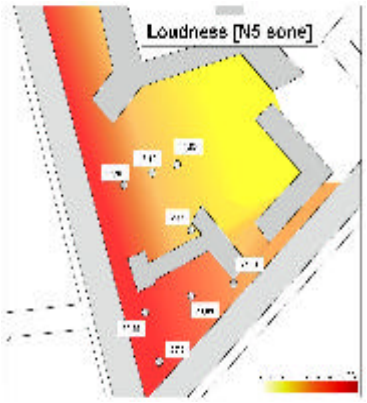
6 Conclusions

The process of tuning of noise pollution with respect to the expertise of people's mind is related to the strategy of triangulation and provides the theoretical frame with regard to the solution of e.g. the change in an area. In other words: Approaching the field in this holistic manner is generally needed when noise research is concerned with unknown social worlds.

An effective and sustainable reduction of the number of highly annoyed people caused by noise is only possible with further scientific endeavors in the area of methods development and research of noise effects. Noise maps providing further information can help to obtain a deeper understanding of noise reactions and can help to reliably identify perception-related hot spots. Psychoacoustic maps are particularly interesting in areas where the noise levels are marginal below the noise level limits and offer an additional interpretation help with respect to the identification of required noise abatement measures. But, only the expertise of people involved can provide meaningful information.



SPL Mapping



Psychoacoustic Mapping

Mind Mapping

So far, the realization of field measurements is indispensable for the determination of psychoacoustic parameter values. Triangulation of data from SPL mapping, psychoacoustic mapping and mapping through the expertise of the local experts will help to develop models for the determination of certain parameters and indicators.

References

[1] R. M. Schafer, *The Tuning of the World* (University of Pennsylvania Press, Philadelphia, 1977

[2] K. Torigoe, *A Study of the World Soundscape Project* (Thesis for Master's Degree, York University, Toronto, 1982

[3] R. M. Schafer, *The Book of Noise* (Price Milburn Co., Lee, Wellington, NZ, 1973

[4] B. Truax, (ed.) Handbook for Acoustic Ecology (A.R.C. Publication, Vancouver, 1978

[5] K. Hiramatsu, “Soundscape: The Concept and Its Significance in Acoustics,” Proc. ICA, Kyoto, 2004

[6] Hollstein, B., Qualitative approaches to social reality : the search for meaning in: John Scott & Peter J. Carrington (Eds.): Sage handbook of social network analysis. London/Newe Dehli: Sage forthcoming)

[7] Fiebig, A., Schulte-Fortkamp, B., Genuit, K. (2006). New options for the determination of environmental noise quality, 35th International Congress and Exposition on Noise Control Engineering INTER-NOISE 2006, 04.-06. December 2006, Honolulu, HI, U

[8] Lercher, P. Schulte-Fortkamp, B. “Soundscape and community noise annoyance in the context of environmental impact assessments,” *Proc. INTER-NOISE 2003,* 2815-2824, 2003

[9] Schulte-Fortkamp, B., Dubois, D: (editors) Acta Acustica united with Acustica, Special Issue, Recent advances in Soundscape research, Vol 92 (6), 2006

[10] Klaboe, R. et al (2000) Änderungen in der Klang- und Stadtlandschaft nach Änderung von Straßenverkehrsstraßen im Stadtteil Oslo-Ost, Fortschritte der Akustik, Oldenburg, 2000

[11] Lercher, P., Brauchle, G. (2000) Die wechselseitige Beeinflussung von externer akustischer und „natürlicher“ Umgebung in einem alpinen Tal: umweltpsychologische und gesundheitliche Perspektiven, Fortschritte der Akustik, Oldenburg 2000

[12] Nitsch, W. (2000) Verkehrsgeräuschprofile von Stadtvierteln. Erfahrungen mit sozioakustischen Feldbegehungen i.R. einer Pilotstudie in Oldenburg und Schortens, Fortschritte der Akustik, Oldenburg 2000

[13] Schulte-Fortkamp, B. (2002) How to measure soundscapes. A theoretical and practicalapproach, in J. Acoust. Soc. Am., Vol. 112, No.5, Pt 2, 2434).

[14] Schulte-Fortkamp,B. “A concept of meaning - sound, sound quality and soundscape”,in: Proceedings, Internoise 2008

[15] R. Volz, A. Jakob, B. Schulte-Fortkamp, “Using the Soundscape approach to develop apublic space in Berlin – Measurement and Calculation”, Acoustics '08, Joint Meeting ofthe 155th Meeting of the Acoustical Society of America, 5th Forum Acusticum, and 9th Congres Francais d 'Acoustique, Paris, France, 2008

[16] B Schulte-Fortkamp, R. Volz, A. Jakob, “Using the Soundscape approach to develop a public space in Berlin - Perception and Evaluation“, Acoustics '08, Joint Meeting of the 155th Meeting of the Acoustical Society of America, 5th Forum Acusticum, and 9thCongres Francais d 'Acoustique, Paris, France, 2008

[17] D. Dubois, C. Gustavino and M. Raimbault, “A cognitive approach to urban soundscapes: Using verbal data to access everyday life auditory categories,” *Acta Acustica united with Acustica* 92, 865-874, 2006.

[18] W. Gaver, “What in the world do we hear? An ecological approach to auditory event perception,” *Ecological Psychology* 5 1–29 (1993