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Urban soundscapes: Experiences and knowledge

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The aim of the present work is to understand how the use of the notion of soundscapes can help in conceiving ambient sound environments in cities. From an overview of recent studies concerned with assessments of sound phenomena in everyday-life situations, the relevance of the soundscape concept is discussed as structuring the categorical space of sounds in cities. Urban planners have been interviewed concerning the soundscape concept in relation to urban projects. This allows comparisons between acousticians', city-users' and planners' categorizations of urban soundscapes, and suggests that a simple decrease of noise level or the elimination of noises is insufficient to account for urban environment improvement.

Keywords: Sound quality, urban environment, qualitative judgment, survey, urban planning and design

Introduction

From noise pollution to the concept of soundscape

Pollution in large cities is an ever-growing problem as the urban environment becomes increasingly crowded. It appears that EU cities are noisier than before, as the noisiest areas become noisier and the quieter areas become less quiet. One reason that urban environments have changed is the increase of traffic flow. The generalized use of motors has led to more low-frequency sounds, resulting in permanent and continuous background noise (Ruocco, 1974; Attenborough et al., 1976). Since the seventies, ''noise'' has been largely considered as a major problem of annoyance in cities and is being taken into consideration by urban planners. Today, the policy of reducing traffic in EU city centres has transposed the problem to the outskirts. Consequently, 20% of the population in European countries is still exposed to excessive road traffic noise, which constitutes a severe health risk. The EU program that aims at ''Reducing Noise Pollution'' to acceptable levels considers noise as part of a global problem facing cities (Stanners and Bourdeau, 1995). As with the evolution of urban ecology policy in the 1980s, the aim is not just to preserve specific areas but to consider the value of local access to places which can constitute valued sanctuaries from noisy surroundings.

Nowadays, town councilors are highly concerned with social well-being in their towns. However, for architects, town planners or landscape designers, knowledge and references are limited in the area of improving environmental quality (Durmisevic and Sariyildiz, 2001). Many field studies have been conducted to measure the outdoor noise environment in several countries, but they are mainly concerned with physical measurements of urban noise. Urban planners make a concerted effort to include human evaluations of environmental quality but subjective evaluations remain sporadic, and urban noise is still considered as unwanted sounds (Mochizuki and Imaizumi, 1967; Fisher, 1973; Canneli, 1974; Fidell, 1978; Elshorbagy, 1984; Brown and Lam, 1987; Garcia and Faus, 1991; Lercher, 1996;

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Gualezzi, 1998; Bogo et al., 2001; Barrigon Morillas et al., 2002; Moura-de-Sousa and Alves Cardoso, 2002; Calixto et al., 2003). Recent studies have pointed out the limits of such approaches (Schulte-Fortkamp, 2002; Schomer, 2003) and made attempts to find new methods of investigation to account for the effects of urban noises on people.

Urban planning management practices have shown that most city regulations are insufficient as they mainly aim at maximum noise weighted levels and therefore focus on physical measurements, neglecting human experiences of noises. Various and contrasted decisions are made concerning noise complaints, noise mapping, noise monitoring or noise abatement and zoning, managing urban noise problems in physical terms only, and not in relation to their physiological and psychological consequences. It appears that sound quality cannot be determined by a simple measurement, such as the usual A-weighted sound pressure level alone (L_{Aeq}).[1] Human perception of noise, in contrast to a physical instrument such as a sound level meter, is not absolute and mainly relies on the meaning of sounds that is in relation to the sources emitting noise and the people who are exposed to it. Therefore, assessment of a sound environment depends on the information content of the sound and the context in which it is perceived (Southwork, 1969). Several authors have pointed to the limits of acoustic parameters such as A-weighted levels (Björk, 1994; Genuit, 1999; Zwicker and Fastl, 1999; Raimbault et al., 2003; Guastavino, 2003; Schomer, 2003), which cannot be used for evaluating annoyance of mixed noise sources in an environment, because of differences in noise spectra recorded from diverse sources and the large variations in noise levels over time. If all sources of noise need appropriate management, measurement and evaluation, an approach which considers the overall question of urban comfort is now essential to evaluate city noise impact and the effects on people. Two main consequences are: first, to account for the assessment of subjective impact of noise in correlation with acoustic parameters, and second, to account for both negative and positive effects of noise in defining the acoustic quality of an urban environment (rather than exclusively focusing on noise annoyance).

An integrated and multidisciplinary approach

The proposed alternative approach regarding the effects of environmental sounds assumes nothing a priori about the exclusively negative effect of noise. Within this framework, our position integrates the notion of *soundscape* initiated by Schafer (1969) as an auditory correspondent of landscape, considering environments and musical compositions as well, and that may be one way to account for noise in cities in a more positive manner, and as a concept to account for subjective experience. The concept explicitly refers to sound variations experienced in space and time, grounded in the topography of the built-up area and different sounding sources. As landscape is viewed as a subjective, personal interpretation however shared by communication, the *sonic environment* exists through the discernment and understanding of individuals, groups and societies alike (Truax, 1978). The soundscape thus accounts for the relationship between the individual experience and subjectivity with a physical and a socio-cultural context. In his studies of soundscape evolution, Schafer (1977) describes more precisely urban soundscapes as complex sonic environments and as cues about socio-cultural life throughout history. The new trend of ecological psychology research also takes into account the fact that natural urban sound environments are always perceived within a simultaneous multi-sensorial setting, in which the diverse sense modalities interact with auditory judgments. The experience of hearing events in the world is the result of interaction between an object at a given time in a given environment (Southwork, 1969; Ballas, 1993; Gaver, 1993; Maffiolo, 1999; Raimbault, 2002).

Soundscapes are always variable in space and time, and can be viewed from a global to a local situation. If the soundscape of a specific space could become an acoustic image for a city, the perceived scale of a sound source is finite. Some sounds may be preponderant during certain periods of time, than others. These temporal variations make it important to distinguish between long-term assessment of the soundscape as experienced during an extended period of time (several minutes, days, months) and short-term perception of the soundscape as perceived ''right now'', even before taking account of the individuals who are also temporally exposed to noise though the duration of their activity. The soundscape may simultaneously contain sounds from several sources, some of which attract the attention more than others, depending not only on the physical characteristics of the signal (such as the intensity), but on its meaning and relevance to the listener. Invariant low-level background noise is, for example, less perceptually salient, even when of high intensity than softer sounds such as birds or people talking. The sound of footsteps that may be incidental can be perceived as an annoyance or just the cue to a pleasant pedestrian area, and therefore may not be appropriate for defining the soundscape. In short, if the measurements rely only on physical measures, it is difficult to obtain valid measures of perceived similarity among long-term soundscapes.

[1]Energy equivalent sound pressure level in A-weighted decibel dB(A). A-weighted decibel is a pressure scale adjusted to conform with the frequency response of the human ear. There are also B-weighted and C-weighted scales, but the A-weighted scale is the one most commonly used for measuring loud noise.

Current research about urban soundscapes tends to include more subject-centered approaches that aim at achieving new knowledge about the adverse effects of noise on health and well-being. Differentiations between soundscapes which can add quality to an environment from annoyance thus improve urban development (Stockfelt, 1991; Skanberg and Ohrstrom, 2002; Lercher and Schulte-Fortkamp, 2003). Therefore, the concept of soundscape can be thought of as an alternative approach to exclusively quantitative approaches to overcome the limits of noise annoyance indicators and to handle more general concepts of sound quality (Schulte-Fortkamp, 2002). In order to develop better skills in treating soundscapes, objective measuring and subjective training research should include far-reaching collaboration between researchers, urban planners and city-users. Such an attempt has already been made by researchers in urbanism and architecture, recently developing the concept of sound ambient environments, quite similar to the concept of soundscape but which, in our opinion, more explicitly claims the need of a close collaboration of physical science and engineering associated with human sciences, such as psychology and sociology (Amphoux, 1993; Augoyard, 1999; Augoyard and Torgue, 1995; Grosjean and Thibaud, 2001). The ambient environment concept leads to new workshops in architecture and urban planning where human aspects of ambient conditions in indoor or outdoor environments are addressed. The empirical work spans a wide range of applications and includes experimental, small- and large-scale fieldwork. To create high-quality ambient environmental conditions, future architects and planners have to know the key concepts about thermal conditions, ventilation and air quality as well as lighting and acoustics which have an effect on the quality of spaces in which we live. This goal requires one to be familiar with both methods of measurement techniques and also how to conduct a human factors analysis of an environment. Urban planners' essential role of decision makings thus has to deal with connecting at least two domains, human sciences and physics. One question remains: How to deal with a set of physical parameters collected from experts' reports and the globally meaningful representations of city-users?

The present work is in keeping with the global pattern of those multidisciplinary projects associating human-centered cognitive research, architecture and physical measurement. First, this paper presents an overview of recent advances in exploring the diversity of city-user practical experiences of soundscapes, as well as experts' knowledge. Previous studies have already analyzed how city-users and residents interpret complex soundscapes into cognitive categories in everyday situations (Vogel, 1999; Maffiolo, 1999; Raimbault, 2002; Guastavino, 2003). However, very few results are known concerning the urban planners' point of view on city soundscapes and how their expert knowledge affects their conception and their work. Interviews of a representative panel of French planners were therefore analyzed in order to understand their awareness concerning the place and utility of sound ambient environments among urban projects. The same methodology was used in previous studies about sound quality of urban environment (Dubois et al., 2005), collecting verbal data and structuring them into semantic categories in order to identify relevant sound quality criteria for urban planners. The present paper thus aims to open a discussion on how to improve our knowledge about the diversity of experiences and representations for urban soundscapes, which would be pertinent for urban planners and for city-users as well.

City-users' experiences of soundscapes

We first stress the importance of avoiding stereotypical notions of environmental noise health effects restrictively grounded on physical and physiological assessments. For example, if the intensity of noise due to traffic, airport or highways is responsible for stress and other health effects, its consequences are generally lower than hearing loss due to amplified music. Nevertheless, the fact is that, in one case, the noise is widely considered as an unwanted and unavoidable pollution and, in the other, as intended entertainment (even if not universally considered as such by neighbors of nightclubs and so forth). The question is therefore to assess health, taking into account the relevance of the activity producing noise to the exposed population. In other words, the judgment concerning the effect of noise on health cannot be made independently of the social value given to the activity under consideration (e.g., necessity of transportation versus pleasure). And therefore, physical measurements have to be integrated into a global judgment that associates physiological, psychological and sociological dimensions that contribute to give individual and collective meanings to the sound effects on city-users.

Non-expert experiences of soundscapes as global and meaningful

In the context of urban environments where noise is produced by various objects, studies show that reactions to simultaneous combined noise sources cannot be predicted from the addition of the reactions to each of the component noises when they occur separately (Berglund and Lindvall, 1995). A psychoacoustic approach still aims to define physical indicators of noise annoyance by adding the contribution of various acoustic parameters but leaves aside the semantic values attributed to sound phenomena as a global effect. Semantic analysis of non-expert verbal data about urban soundscapes has shown that a unique acoustical phenomenon could give rise to various cognitive objects that could

be contrasted through the two labels of ''*bruits*—noises'' and ''*sons*—sounds'', considering the semiotic processes and the language resources diversely associated to a unique stimulation (Dubois, 2000). It has been observed that the most frequently reported linguistic devices used (in French as well as in English) to describe the category of ''noises'' are names of the object sources attributed to the sound sources (such as ''le bruit de mobylette'', i.e., ''the noise of motorbikes'' or ''alarme de voiture'', i.e., '' car alarms'') and nominal forms constructed on verbs (''grincement de frein'', i.e., ''squeaking of brakes''), whereas ''sounds'' are lexicalized as acoustic patterns mainly by adjectival forms borrowed to the technical terminology (high, low, pitch, rough, sharp). These findings highlight the fact that soundscape descriptions are differently processed and interpreted, through the shared meaning given to the object-source emitting noise, rather than to perceptual features, that could be reduced to their description as physical properties of ''sound''. Such cognitive semantic approaches suggest a more holistic description to noises as meaningful events that affect people. Reports of previous work on soundscapes strengthens the importance of meanings given to sound sources as cues within a global interpretation that integrates multimodal experience as well as what is generally considered as ''context'' (Susini et al., 1998; Mzali, 2002; Raimbault, 2002; Guastavino, 2003).

Soundscape experiences in a multimodal context

The background noise or ambient noise context appears to influence the reaction to a specific environmental noise. These findings actually highlight the significance of other aspects depending on the context that drives the interpretation of acoustical features, such as the structure of urban areas, architectural (visual, aesthetic) lifestyles and social parameters (Schulte-Fortkamp, 2002). There is therefore no simple conclusion about the role and importance of non-acoustic factors associated with environmental noise. For example, on-site analysis of sound ambient environments shows that various urban situations with similar noise exposure levels, such as the vicinity of a playground in a residential area, a town square with commercial and leisure activities or a city-center market square, do not present the same assessment and depend on the activities producing the noise (Raimbault et al., 2003). Moreover, non-acoustical features of the environment influence assessment of its soundscape, such as areas where air pollution is obvious or visual aspects neglected (Dubois et al., 1998; Flindell and Stallen, 1999; Job, 2001). The visibility of an unwanted noise source may also add negative reactions to the soundscape itself even if the noise is out of earshot (Maffiolo, 1999; Viollon et al., 2002). Similarly, living on a ''pretty street'' could reduce noise annoyance (Lercher and Schulte-Fortkamp, 2003).

It is therefore now widely accepted that a personal response depends as much on the listeners' state of mind and attitudes (psychological and sociological factors) that drives their interpretation as on physical noise level alone. It explains the significant individual differences that have been observed in reaction to noise (Job, 1999). Consequently, collective decisions have to deal with such variations and therefore to integrate differences across and within communities. For example, in a previous study of diverse urban locations, we notice the heterogeneous assessments among people concerning temporal, spatial and activity features of soundscapes, and identify two cognitive representations of urban soundscapes: a descriptive listening which refers to the identification of specific acoustic sources or events and a holistic hearing which refers the soundscape as a whole, without semantic processing of any particular sources (Raimbault, 2002; Raimbault and Dubois, submitted). We therefore suggested a more subject-centered methodology which aimed at evaluating the diversity of meanings from annoyance to pleasure in an urban environment that contributed to better understanding of sound quality criteria in cities and to provide keys for soundscape design and management. This methodology and conceptual framework—which refers to the interpretation of sound variations in space and time—is also and has been applied in designing new environments, by means of the analysis of what could be an ideal soundscape for city-users, on one side, and what could be the representations of it by urban planners.

Ideal urban soundscapes for city-users

When questioning subjects about what could be an ideal soundscape for them, Guastavino's (2003) analysis clearly underlines relevant sound quality criteria and reveals the meaningful salience of human produced sounds: while soundscapes mostly composed of traffic noise were described as unpleasant, ideal soundscapes were described as including a lot of human noises and were subcategorized according to the significance of the type of socialized activities performed and producing noises. This confirms Stockfelt's (1991) point of view, that sound is an existential necessity: soundscapes are essential for well-being, not only as music but as an integral part of living situations. This also confirms Schafer's (1977) conception of ''tuning the world'' to make it more pleasant, as well as our findings on the resignation of people regarding unavoidable noises of traffic and some specific human activities (Raimbault, 2002; Mzali, 2002). If ideal urban soundscapes should reflect life through sounds communicating human presence and activities, noise annoyance is interpreted by the fact that ''traffic'' is the obvious salient factor describing the environment of cities (Raimbault

and Dubois, submitted). These findings point to the fact that urban planners should account for these psycho-social experiences as well as expert physical requirements in order to compose new urban soundscapes. It becomes clear that it is the semantic properties that play a decisive role because sounds fulfill distinctive functions. These semantic properties of sound sources allow us to assess the diversity of urban soundscapes, highly dependent on the outside/inside or public/private or street/home socio-cultural way of life and activities. To evaluate urban soundscapes, it is thus required to analyze semantic properties attributed to sound sources and not only by noise level measurements. Based on such concepts adapted from communication science and semiotics, a model which supports the classification of auditory events is therefore suggested.

Meanings and classification of soundscapes

Schafer's (1977) and Delage's (1979) semantic criteria for their soundscape classifications allow us to distinguish: road traffic (car–truck–motorcycle), other transportation (railway, aircraft), working machines (street cleaning, working site), music, people's presence (speech, walking), and nature (wind, animals). They however remain environment- or object-centered descriptions. Complementary to such an approach, classifications resulting from previously cited research (Maffiolo, 1999; Raimbault, 2002; Guastavino, 2003) contrasted two main categories, namely: transportation or works (from road traffic, railway, building site) versus people presence (from departmental store, coffee shop terraces, traveling shoppers), therefore shifting to a more subject-centered representation of soundscapes categories. Furthermore, both of these categories could be subcategorized as illustrated in *Figure 1*. Categories of transportation or works were set up in either in-between soundscapes associated with people presence or amorphous soundscapes without any other presence. Likewise, a defined category of people presence was divided into lively soundscapes (with animation such as music, activities) and relaxing ones when linked to patterns of nature (such as birds in trees, fountains), thus connecting objects to activities through a functional point of view that can be used by city managers. One attempt to solve urban problems of noise management may then be the use of variations in the soundscape to create more pleasant sound ambient environments. For example, soundscape concerns in cities could be connected at some point to the question of function through the management of urban activities (as shown in *Figure 1*).

Soundscape concept and urban planners

We hypothesize the usefulness of making the diversity of object-centered and human-centered representations of soundscapes explicit. Their relatedness may fill the gap encountered by town planners who have to decide on arguments and settle a choice for improving the sound quality of their towns.

A recent study about the opinions of French Parliament members concerning environmental problems shows that economic development concerns always came before environmental ones. Noise policies reach ninth place only, far after water control or waste management (Boy, 2003). Comparison of the elected representative and the general public attitudes always revealed an important shift. After presenting city-users' experiences of soundscapes, our investigations were therefore concerned by decision makers' and planners' awareness about the place and utility of the soundscape concept among urban projects. Interviews were carried out to investigate the attitudes and habits of a representative panel of urban planners and decision makers, as it was done for city-users. The analysis then went on classifying the collected verbal data into semantic categories in order to identify relevant sound quality criteria for this population.

Method of interviewing urban planners

The questionnaires were designed to include general questions about main ideas in urban planning management, technical criteria, integration of city-user expectations, as well as more specific questions about the soundscape concerns. Respondents were not informed that the focus of the study was noise. Ten engineers, architects, town planners and landscape designers from various institutions participated in the experiment. They were volunteers, not rewarded for their participation. The limited number of participants is compensated by the importance of open talk content of the 2 h interviews that constitute a sample diversity which starts to set up an inventory of the opinions and the representations that could be further investigated on large samples with structured questionnaires.

The fully re-transcribed verbal data were processed through *Nomino*[2] linguistic software to identify the main lexical categories that could give access to the main topics given by the subjects. A coding grid paid specific attention to the categories concerned with urban management in general and soundscapes in particular. The collected verbal data about soundscapes were analyzed referring to a previous psycholinguistic grid relevant for the study of non-expert comments (as shown in *Figure 2*) in order to compare planners' descriptions with those of others.

A decision centered organization

Firstly, categorical analysis of answers to general questions showed that the main criteria for an urban

[2]*Nomino et ALN*, Plante, P., Dumas, L., Plante, A., ATO Fac. Sc. Humaines, Univ. Quebec, Montréal, Canada.

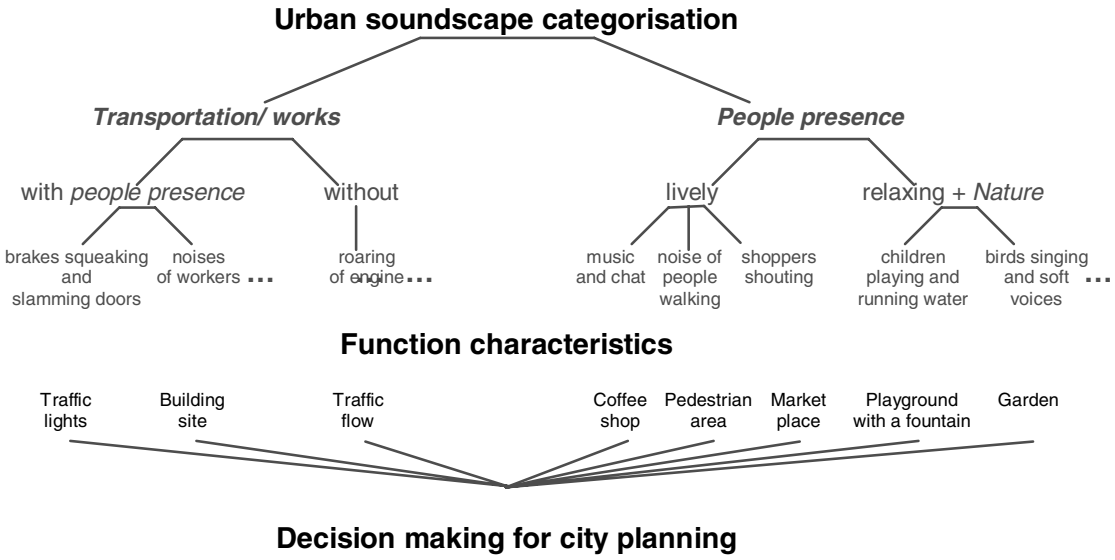

Figure 1 Categorization of urban soundscapes from subjects' descriptions and their relations to potential functions for city management.

project were financial queries, functional questions, safety standards and embellishing touches, such as: ''what would be the costs of any decision and what would be the benefits?''. Analysis of the verbal data also revealed that urban planning needs arbitration between several interests concerned with the same goal: urban situational improvement. The management of urban operations thus required the coordination of many partners, such as residents and city-users (mainly through local organizations), prime contractors (urban planners, technical designers) and contracting authorities (national and various administrative town departments). In view of the main criteria for an urban project, the place and role of noise in cities were limited. Nevertheless, if city noises are not the main concern for prime contractors, noise management considerably involves the contracting authority, such as town councilors who are interested in satisfying public opinion.

Secondly, the verbal analysis of the specific answers about soundscape underlined a lack of consensual description: planners are lacking a vocabulary for describing their expectations or even to take stock of urban situations with regard to sound.

The main points concerning soundscape concerns inferred from verbal analysis of planners' and decision makers' interviews are therefore the following:

i. Planners and decision makers reported an increase of noise annoyance, which is not just a recent problem. Urban planners then blamed the use of noise as a reason for complaining about the noise, even if the problem is somewhere else, in order to get the authorities to do something.
ii. Ambivalence was often recognized concerning urban noise assessments since ''noise is life'' but also ''too much noise is annoying''. The question is asked of how much noise is ''too much'' noise?, considering the difficulty of assessing the listener's state of mind, and a lack of relevant knowledge and expertise in the human sciences. The question of noise is therefore often avoided in urban planning as being too difficult to deal with.
iii. When describing urban soundscapes, planners and decision makers used the comparisons of contrasted urban situations, varied in activities (mixed noises of sound sources), locations (parts of town, centre or suburbs) or time (various moments and durations) in a way similar to city-users (beside their expert knowledge, they may also be city-users).
iv. Finally, planners were suspicious about noise evaluation methods since there was no effective balance between either technical vocabulary or measure by experts and usual description of noises. This underlines the limits of the pervasive engineering focus on silence which appeared the most dominant aspect of current regulatory approaches to noise control management.

The categorical linguistic analysis showed that planners used a much more technical vocabulary and generic expressions when describing soundscapes than city-users could do (as illustrated in *Figure 3*). They refer more to an object-centered

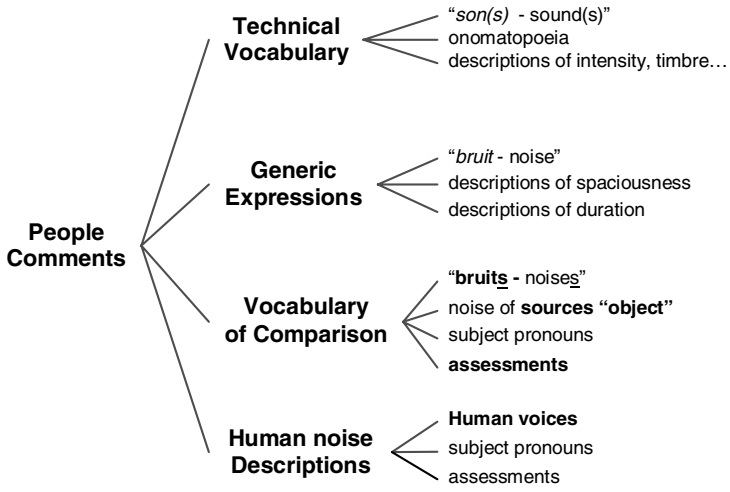

Figure 2 Psycholinguistic categorization of collected verbal data about soundscapes.

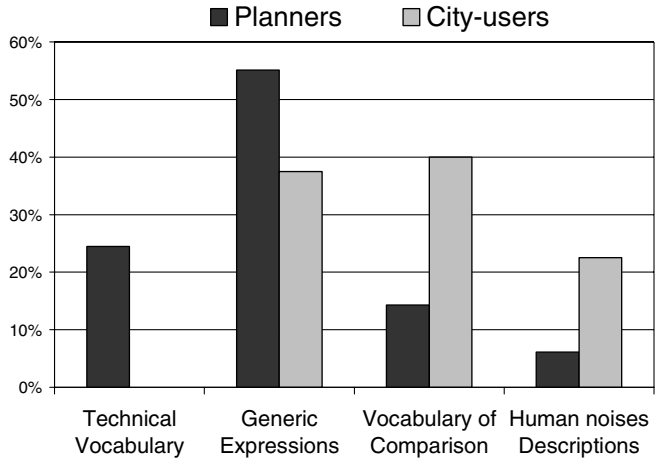

Figure 3 Comparison between planners' verbal descriptions of soundscapes and city-users' ones, the latter synthesizing on-site results of Raimbault's study (2002).

concern than to a human-centered one, even if their descriptions of sound ambient environments were often linked to other multimodal criteria, such as visual, aesthetic or functional parameters. This could be explained by that fact that planners and decision makers were more essentially worried about noise complaints and noise management, than to ambient quality that would also enhance positive values (expected when they become city-users).

Analysis of vocabulary of comparison or human noise descriptions showed that various sound sources were listed through the descriptions of urban situations where noises are mixed in an environment. All listed sound sources were mainly classified by planners in two groups (presented in *Figure 4*): natural noises in contrast to noises from activities (transport, neighborhood, industries or leisure) but mainly conceived as annoyance, resulting from a specific attention to complaints. Planners then used their knowledge regarding either attested health effect or individual complaint criteria to evaluate separately the sound sources.

Analysis of the specific answers about soundscapes highlighted that the only matter in engineering noise control remains currently the noise level. Planners however questioned the generic concept of the noise level, if not related to the identification and thus the qualification of a source. The shared point among these results is that, even if standards are the only argument of urban noise control, they are greatly criticized as being insufficient to assess the multifaceted question of noise in cities: an architect commented: ''Standards are certainly useful but in urban or architectural projects, it is useless! If people are disturbed, they do not care about being in a situation that conforms to the norms. We are in the qualitative concern''.

All these results lead to the ambiguous position of urban politics and planners, expecting more noise policy and arguing the overstatement of noise as a community problem. These findings highlight the difficulty of dealing with the soundscape concern in the global question of urban management and also indicate the need to increase public awareness concerning urban soundscapes. Nevertheless, if all the voluntary participants felt concerned by the purpose of the interviews, none had specific expectations concerning new professional tools for analyzing soundscapes in cities. Their main concern was to be proposed helpful tools which were adapted for urban planning processes and therefore well defined in communicating and understanding design patterns.

Consequences for planners and managers

City-users' experiences: semantic diversity

Even though pieces of knowledge have been learned about people's assessment of soundscape, many questions remain. The review of city-user experiences of soundscapes shows that predicting sound qualities of an environment or the impact of noise on individuals is far more difficult than estimating levels of physical noise exposure with engineering methods. If researchers could appreciate the distinction between these two statements, regulatory authorities and prime contractors should often adopt measurements to settle a decision. Important choices for urban soundscapes could therefore be made relying on inadequate information based on incomplete knowledge about acoustic phenomenon in cities, elaborated from a diversity of urban experiences and points of views.

Experts in noise control lead to an urban soundscape becoming less negative (less unpleasant) without being more positive (pleasant) whereas city-users' and planners' assessments of urban soundscapes show that the quality of soundscapes refers to the question of quality of life, way of life and activities. Urban planners and contracting authorities agree about the elective point of systematically eliminating noise. Comparisons of city-users and urban planners' experiences of urban soundscapes allow us to infer that a decrease of noise level or the elimination of noises from urban environments is not sufficient and can even create anxiety or reveal other problems. Town councilors should therefore inform themselves about this diversity of representations in order to work out new information programs to the public regarding the effects and control of noise, considering that insufficient attention to sounds is provided in school or in public or work places.

Analysis of the urban planner's point of view about soundscape concepts shows that the consideration of non-acoustic factors causes difficulties in urban noise evaluation and that there is probably no simple answer anyway to soundscape management in cities. These conclusions are in agreement with Chalas' (1998) previous study about decision making in French urban management concerning noise policy: there is no simple or unique answer to various specific problems and urban soundscape concern is much more a question of partnership, negotiation and interactions. Chalas (1998) concludes his work by defending the complexity of the noise question in cities and explains why urban planners need more global and transversal approaches between different partners. Moreover, Flindell and Stallen (1999) explains that effective noise management is a matter of choosing between alternatives and informed selections to improve co-ordination and coherence in the decision making and not only engineering noise control. All these studies about urban planning management reach the same conclusion: the way the question is handled and the way the decision is taken could be more significant than the achievement of a ''simple'' physical noise level reduction. One suggestion is to shift to the question

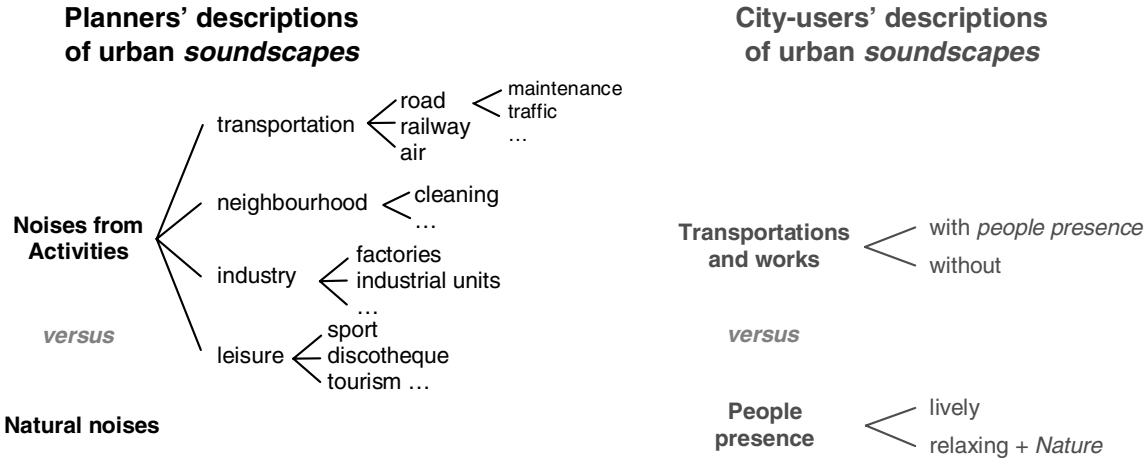

Figure 4 Comparison between planners' and city-users' verbal descriptions of urban soundscapes.

''how to conceive and design desirable soundscapes'' rather than just ''how to technically eliminate noise''.

Structuring of the soundscape concept with urban planning and design purposes

Appraisal of a soundscape depend mainly on the way it matches with the setting in which it occurs (Carles et al., 1999). The soundscape congruence in shaping urban locations may be interpreted with reference to the informational content of the sound. We therefore propose to analyze urban soundscapes through the identification of activities in urban environment, the meaning given to acoustic phenomena and consequently the management of functions. In the past, form follows function and basic design has always been in search of the best shape for the best use. Sound could then symbolize the contents and space of the container. Characteristic urban morphologies propose settled functions, which activities create various soundscapes, such as the one illustrated in *Figure 5* (medieval architecture, Haussmann's buildings, modern infrastructure). Sound marks would subsequently shape territories, such as sound signals (birds, footsteps, voices) or music backgrounds. The matter is not to let everything taking place every time everywhere, but rather to plan soundscape to improve the quality of everyday life. One attempt to make this part of enhancing the quality of life in cities is to create less homogenous acoustic environments and diversely meaningful ones. For example, usual noise barrier changes the perceived soundscape, making the traffic noise perceptually more homogenous and harder to localize when the challenge should be how to monitor the overall problem of traffic if it gets worse or better. The issue for soundscape design and management thus integrates the overall goal of urban comfort in cities. Several action steps are proposed to effectively assess the urban soundscape, based on activity modalities which defined a determine scale and time for a semantic analysis.

First, all sound sources in the vicinity of the soundscape should be identified and noted. Then, planners have to take into account the local contexts of the sound sources, the interaction of which gives meaning to the perceived noise. Soundscape management would be achieved knowing source representations for city dwellers and the community. For example, attitudes toward characteristic noise sources of an area could transform noise acceptability, such as factory noise which symbolize both the community and a source of annoyance. The proposed classifications in basic meaningful categories

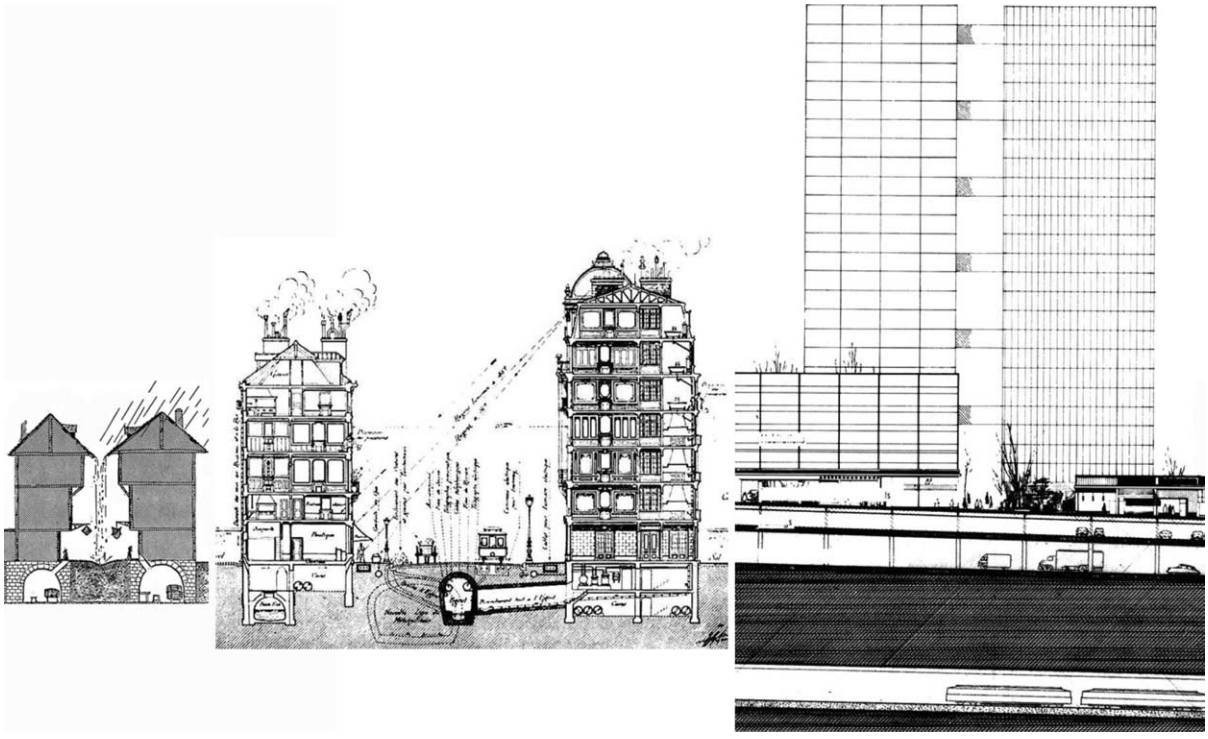

Figure 5 Sample of typical urban morphologies, such as medieval architecture, Haussmann's buildings, and modern infrastructure. Drawings from Raimbault (2002) in order to exemplify visual cues for would-be soundscapes of urban European locations. Densification has stimulated building higher and underground. These various patterns of architecture illustrate how building scale has changed over time, shaping urban forms and consequently their sound ambient environments.

(*Figure 1*) aims at helping planners to decide on the variation in the soundscape design and management of their town, combining the transportation or work with people presence and natural features.

Secondly, observation of the soundscape time variations is of importance. Soundscape management would be achieved knowing the current state of soundscape description in comparison to the past one, even if it is difficult to imagine how it changes across distance. Passage of time and rhythms of activities in daily life highlight specific period of concern, such as the evening and night for residential areas or during mid-day till late afternoon for pedestrian areas.

After analyzing the social, local and temporal contexts of the soundscape, specific measurements can be processed based on the knowledge of what to measure, where, when and along which period of time. Long-term acoustic measurements intend to assess problems at a regional level whereas short-term measurements have to facilitate solutions at a local level. The present article focuses on propositions for the latter temporal dimension (short term at a local level) where consideration of noise source is essential. The measurements thus have to give pertinent information about the noise source. Recent research on noise measurement systems is working on the improvement of noise source automatic identification. Our proposal is to use deserved measurements related to specific locations of functions over the duration of characteristic events. Currently, most countries use the A-weighted equivalent level (L_{Aeq}) to assess the annoyance of most noise. It provides a constant filter that is independent of sound source identification. To properly assess soundscapes across differing noise sources, a metric should take into account the variations in low-frequency sound energies that the A-weighted decibel does not (Leventhall, 2004). For example, when A-weighted sound pressure level is a convenient tool for noise annoyance assessment of any single transport source over a period of time, it cannot be compared with the A-weighted sound pressure level of a pedestrian area. Even if all these sound pressure level indicators reflect loudness, they do not directly reflect annoyance and planners should never overlook that point. For example, urban parks attract people because of the environmental setting, facilities and they become refuges from urban noise, even if parks are physically evaluated as ''too'' loud from a sound pressure level point of view. In locations next to major roads, natural sound from sources like birds, wind and water structures offset the effect of urban noise, even if increasing sound levels. Other kinds of physical indicators can be used to evaluate time variations of urban soundscape: the noise index over 90% of a period of time for characterizing the background noise pressure level, the duration of emergencies or specific events or the period between those emergencies. All these indicators have to be linked to the outline characteristics of all noted sound sources (type, number, occurrences, location and distance) which are much more meaningful for decision makers, urban planners and the general public as well.

Finally, it is of interest to study the acoustical qualities of specific material and key concepts about urban shapes sound effects (U-shape road, housing estate, 1950s suburb). Acute utilization of material then enhances specific sources or reduce some others referring to the specifications of an urban project. Various identified sounds in a space contribute to its sound identity. Design of spaces goes through harmonization of the source objects taking into account the functions and activities that occurs. Therefore, to design a soundscape means to contribute to specific sound intelligibility in order to create comfort, well-being, and emotions, in opposition to traditional noise abatement methods. To exemplify how the soundscape concept can be operationalized, some guidelines for a novel city noise mapping approach are proposed as a tentative conclusion.

Soundscapes in practice: from research to decisions

Nowadays, European noise programs aim at elaborating a strategic noise map of all major agglomerations (with more than 100,000 inhabitants) in EU countries through estimation of A-weighted sound pressure level measures (L_{DEN}).[3] EU member states have to set up strategic maps with noise measurements or with a sound prediction computation method which takes into account industrial, aircraft, road and railway noise sources. If uniform exposure indicators, comparable calculation methods and noise mapping procedures represent significant breakthroughs for urban planning, standard noise exposure contour maps are difficult to interpret by non-experts (politicians, planners and city-dwellers) who are neither familiar with the L_{DEN} traffic noise exposure measures nor their associated impacts at a level of specificity that gives meaning to them. Nevertheless, those noise maps are going to be used by decision makers, urban planners, and the general public who are not experts in acoustics.

A recent study of the noise map by would-be users already shows a gap between the expectations of the EU Commission and those of the decision makers and the general public (Lambert et al., 2004). The public is expecting much more from a noise map than it can actually afford, such as the type of the evaluated noise sources (other than transport), or the subject matter (what the noise levels mean?). The public are in fact newcomers concerning noise units of experts in acoustics, such as the A-weighted

[3]The day–evening–night level (L_{DEN}) is a descriptor of noise level based on energy equivalent noise level (L_{Aeq}) over a whole day with a penalty of 10 dB(A) for night time noise (22.00–7.00) and an additional penalty of 5 dB(A) for evening noise (i.e., 19.00–23.00).

decibel or sound pressure levels (L_{Aeq}, L_{DEN}). How could those maps serve as tools for getting popular support for funding noise planning projects with information that the public cannot understand? This result has to be considered more as a matched requirement for meaningful indicators rather than just the recording of divergent points of view, in order to contribute to the effectiveness of the new European Directive applications. It should be kept in mind that noise planning projects are in competition with other projects and making claims for scarce municipal, regional and national resources. For those reasons, traditional noise exposure maps are to some extent ineffective in providing relevant information for global and local action plans.

Moreover, it can be stated that noise levels in typical city configurations with narrow streets are strongly influenced by secondary sources like pedestrians or other activities. Variations in the size of nearby noise impacts make it difficult to get an overall impression of urban areas and the contribution of secondary sources is rather difficult to estimate. Therefore, noise mapping with prediction method estimation appears not fully realistic in some urban districts if only noise traffic on the main roads is considered (Maffei et al., 2004). For that reason, it is now interesting to start a new semantic approach that aims at identifying secondary sources and improve urban soundscape assessment.

An ideal map proposal would help to identify, in meaningful terms and descriptions, a number of specific urban areas that are qualitatively enhanced by characteristic soundscapes or adversely affected by noise. Overlay techniques may provide complementary observations, such as where people live, work, or which type of noise they are exposed to. However, multi-layer maps could be quickly overloaded with information and became even more unsuitable for the non-experts. A proposed method to improve noise mapping would therefore be to chart soundscape impacts of urban areas, such as transportation and works (traffic, maintenance, cleaning, factories, and industrial units), people presence (leisure activities, neighborhood) or natural environments, considering various sized areas, where the different categories of soundscapes were identified. A soundscape database involving subjective assessment would be constructed considering the classification system proposed (*Figure 1*) and developed in Section 4.2 as a first systematic attempt. Soundscape quality areas are here defined as areas where locals and city-users perceive their environment as an entity belonging to a more general category. The classification of soundscape quality areas then corresponds to the tendency of those urban areas to produce a given experience through the known description of their characteristics, in terms that are more meaningful for politician, decision makers, planners and city-users. The areas are cartographic generalizations of soundscape impacts to make spatial analyses more effective and to improve visual communication. The use of activities notification to identify soundscape colors of the urban environment helps to get to a third dimension with qualitative information on a standard two dimensional map.

In conclusion, we expect that the identification of a variety of soundscape areas in cities, relying on human-centered categorization, would help decision making, and research on the development, expansion, re-organization or modernization of urban structures. On more general ground, we would emphasize that the understanding of urban soundscapes needs to expand multidisciplinary research, involving a balanced partnership between acoustical and psychosociological investigations. Such a human-centered approach contributes to the analysis of cognitive representation of soundscapes and improves the identification of relevant physical parameters of noises in urban situations.

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References

Amphoux, P (1993) *L'identité sonore des villes européennes, Guide méthodologique*. Report 26, Cesson, Grenoble, 89.

Attenborough, K, Clark, S and Utley, W A (1976) Background noise levels in the United Kingdom. *J. Sound Vib.* **48**, 359–375.

Augoyard, J F (1999) The Cricket Effect. Which tools for the research on sonic urban ambiences? In: From awareness to action. *Conference on acoustic ecology*. Karlsson, Stockholm, pp. 1–7.

Augoyard, J F and Torgue, H (1995) *A l'écoute de l'environnement. Répertoire des effets sonores.* Parenthèses, Marseille, p. 174.

Ballas, J (1993) Common factors in the identification of an assortment of brief everyday sounds. *J. Exper. Psychol.* **19**, 250–267.

Barrigon Morillas, J M, Gomez Escobar, V, Mendez Sierra, J A, Vilchez Gomez, R and Trujillo Carmona, J (2002) An environmental noise study in the city of Caceres, Spain. *Appl. Acoust.* **63**, 1061–1070.

Berglund, B and Lindvall, T (ed.) (1995) *Community noise.* Document prepared for the World Health Organisation. Arch Centre for Sensory Research **2**, 1–195.

Björk, E A (1994) Community noise in different seasons in Kuopio, Finland. *Appl. Acoust.* **42**(2), 137–150.

Bogo, H, Gomez, D R, Reich, S L, Negri, R M and San Roman, E (2001) Traffic pollution in a downtown site of Buenos Aires City. *Atmospheric Environment* **35**, 1717–1727.

Boy, D (2003) Les parlementaires et l'environnement. *PROSES* **7**, 1–27.

Brown, K A L and Lam, C (1987) Urban noise surveys. *Appl. Acoust.* **20**(1), 23–39.

Calixto, A, Diniz, F B and Zannin, P H T (2003) The statistical modelling of road traffic noise in an urban setting. *Cities* **20**(1), 23–29.

Canneli, G B (1974) Traffic noise pollution in Rome. *Appl. Acoust.* **7**, 103–115.
Carles, J L, Lopez Barrio, I and Vicente de Lucio, J (1999) Sound influence on landscape values. *Landscape and urban planning* **43**, 191–200.
Chalas, Y (1998) *L'imaginaire sonore politique*. Report. Cresson, Grenoble, **122**.
Delage, B (1979) *Paysage sonore urbain*. Report. Plan construction, **79** (27).
Dubois, D (2000) Categories as acts of meaning: the case of categories in olfaction and audition. *Cognitive Science Quaterly* **1**, 35–68.
Dubois, D, David, S, Resch Rigon, P, and Maffiolo, V (1998) *Etude de la qualité sonore des espaces verts de la ville de Paris*. Report Mairie de Paris, 135.
Dubois, D, Guastavino, C and Raimbault, M (2005) Les catégories cognitives du bruit urbain: des discours aux indicateurs physiques. *Acoustique & Technique* (39), 49–57.
Durmisevic, S and Sariyildiz, S (2001) A systematic quality assessment of underground spaces—public transport stations. *Cities* **18**(1), 13–23.
Elshorbagy, K A (1984) Environmental acoustic quality in Jeddah urban sites. *Appl. Acoust.* **17**(4), 261–274.
Fidell, S (1978) Nationwide urban noise survey. *J. Acoust. Soc. Am.* **64**, 198–206.
Fisher, G H (1973) Current levels of noise in an urban environment. *Appl. Ergonomics* **4**(4), 211–218.
Flindell, I and Stallen, P J (1999) Non-acoustical factor in environmental noise. *Noise and Health* **3**, 11–16.
Garcia, A and Faus, L J (1991) Statistical analysis of noise levels in urban areas. *Appl. Acoust.* **34**, 227–247.
Gaver, W (1993) What in the world do we hear? An ecological approach to auditory event perception. *Ecological Psychology* **5**(1), 1–29.
Genuit, K (1999) The use of psychoacoustic parameters combined with A-weighted SPL in noise description. *Internoise* 99, Fort Lauderdale, Fl USA, 1887–1892.
Grosjean, M and Thibaud, J P (2001) *L'espace urbain en méthodes*. Parenthèse, Marseille.
Gualezzi, J P (1998) *Le bruit dans la ville*. J. Officiel, Paris, 287.
Guastavino, C (2003) *Etude sémantique et acoustique de la perception des basses fréquences dans l'environnement sonore urbain* (Ph.D. Thesis). Univ. Paris 6.
Job, R F S (1999) Noise sensitivity as a factor influencing human reaction to noise. *Noise and Health* **3**, 57–68.
Job, R F S (2001) The impact of soundscape, enviroscape and psychscape on the reaction to noise: Implication for evaluation and regulation of noise effects. *Noise Control Eng. J.* **49**(3), 120–124.
Lambert, J, Guerin, D, and Vincent, B (2004) GIpSyNOISE: Expectations of the cities and the citizens toward noise mapping. In: *Inter-noise* 2004, Prague, Czech Republic.
Lercher, P (1996) Environmental noise and health: an integrated research perspective. *Environmental International* **22**, 117–128.
Lercher, P and Schulte-Fortkamp, B (2003) The relevance of soundscape research to the assessment of noise annoyance at the community level. In: *ICBEN 8th International congress on noise as a public health problem*, Rotterdam, The Netherlands.
Leventhall, H G (2004) Low frequency noise and annoyance. *Noise and Health* **6**(23), 59–72.
Maffei, L, Iannace, G and Lembo, P (2004) Noise levels prediction in cities with an ancient urban structure. In: *Internoise* 2004, Prague, Czech Republic.
Maffiolo, V (1999) *De la caractérisation sémantique et acoustique de la qualité sonore de l'environnement sonore urbain* (Ph.D. Thesis). Univ. du Maine, 285.
Mochizuki, T and Imaizumi, N (1967) City noise in Tokyo. *J. Acoust. Soc. Japan* **23**, 146–159.
Moura-de-Sousa, C and Alves Cardoso, M R (2002) Urban noise in the city of Sao Paulo, Brazil: an important problem of public health. *Noise and Health* **4**(16), 57–63.
Mzali, M (2002) *Perception de l'ambiance sonore et évaluation du confort acoustique dans les trains*. (Ph.D. Thesis). Univ. Paris VI, 255.
Raimbault, M (2002) *Simulation des ambiances sonores urbaines: intégration des aspects qualitatifs* (Ph.D. Thesis). Univ. Nantes, 268.
Raimbault, M and Dubois, D (submitted) Qualitative judgements of urban soundscapes using open questionnaires and semantic scales.
Raimbault, M, Lavandier, C and Bérengier, M (2003) Sound ambient assessments of urban environments. *Appl. Acoust.* **64**, 1241–1256.
Ruocco, M R (1974) Background noise. *Environmental Health*, 6–11.
Schafer, M R (1969) *The new soundscape*. Universal Edition, Vienna.
Schafer, M R (1977) *The tuning of the world*. Knopf, New York.
Schomer, P D (2003) Does the Soundscape concept have real utility. *Internoise 2003*, 2825–2826.
Schulte-Fortkamp, B (2002) The meaning of annoyance in relation to the quality of acoustic environments. *Noise and Health* **4**, 13–28.
Skanberg, A and Ohrstrom, E (2002) Adverse health effects in relation to urban residential soundscapes. *J. Sound Vib.* **250**(1), 151–155.
Southwork, M (1969) The sonic environment of cities. *Environment and Behavior* **1**, 49–70.
Stanners, D, Bourdeau, P(eds.) (1995) *Europe's environment*. Copenhagen European Environment Agency.
Stockfelt, T (1991) Sound as an existential necessity. *J. Sound Vib.* **151**(3), 367–370.
Susini, P, Misdariis, N, Winsberg, S and McAdams, S (1998) Caractérisation perceptive de bruits. *Acoustique et Techniques* **13**, 11–15.
Truax, B (1978) *The handbook for acoustic ecology*. A.R.C. Publications, Vancouver.
Viollon, S, Lavandier, C and Drake, C (2002) Influence of visual setting on sound ratings in an urban environment. *Appl. Acoust.* **63**, 493–511.
Vogel, C (1999) *Etude sémiotique et acoustique de l'identification des signaux d'avertissement en contexte urbain*. (Ph.D. Thesis). Univ. Paris VI, 223.
Zwicker, E and Fastl, H (1999) *Psychoacoustics—facts and models*. Springer Verlag, Berlin.