

Quiet urban areas: repositioning local noise policy approaches – questioning visitors on soundscape and environmental quality

As a recent WHO report, published in 2011, demonstrates, noise is, after air-pollution, the second most important environmental stressor in Western Europe. With the current noise exposure levels, more than 1 million healthy life years are lost annually due to the long term exposure to noise. Not surprisingly, the European Commission and Parliament recognised the need for addressing this environmental health problem in their Green Paper in 1996 and established the Environmental Noise Directive in 2002. The main aim of this directive is to identify the seriousness of the problem and subsequent policies to be strengthened or newly developed.

In order to obtain this knowledge and insights, competent authorities such as national road authorities and large cities had to draft strategic noise maps and subsequent action plans in which measures for addressing noise problems and polluted areas were presented. The strategic noise maps delivered by the end of 2007 showed that around 40 million people across the EU are exposed to noise above 50 dB from roads within agglomerations during the night. More than 25 million people are exposed to noise at the same level from major roads outside agglomerations. One should note that this data is provided by the largest cities in Europe; and as such we are now all awaiting new updated information from even more European cities as smaller agglomerations of 100.000 and more inhabitants this year had to draft noise maps as well. The expectation is that the number of annoyed and sleep disturbed citizens will increase with 30 to 40%; no doubt about the seriousness of noise pollution and the priority that has to be given to enhancing quality of life and health of the European population.

Since some decades international and national policies are in place in order to avoid, prevent, and reduce noise exposure. Examples are the traditional governmental approaches of top-down command-and-control policy instruments, such as international regulations on emissions from vehicles and their tyres, and national regulations on noise immission levels at the facades of dwellings. Overall we could conclude that these policy instruments have been effective; living conditions would have been far worse without these policies. Specifically when considering societal changes such as increasing population, and the related increasing levels of car ownership, mobility, 24 hour economy and other economic activities. Due to these noise abatement policies noise barriers have been erected, low noise pavements are applied, houses are insulated and zoning and spatial planning separate noisy activities such as infrastructure and industries from noise sensitive residential areas.

However, there is a need for additional policy approaches at regional and local administrative level. The European Commission and Parliament recognised the need to shift towards other governance based approaches as well, in relation to quality of life and health. As we can read from the dose-response curves developed by Miedema in the 1990s, living in residential areas with relatively low to average noise cumulative levels avoids or at least limits adverse health effects such as annoyance, stress, cardio vascular diseases and sleep disturbance. In addition, recently more research is available showing that relatively quiet areas in the vicinity of one's house are advantageous for health and well being. Evidence shows that access to a quiet area, such as a city park, with noise levels of LAeq below 45 dB reduces annoyance and improves well being. Other research by for example Kaplan in 1995 and Alvarsson, Wiens and Nilsson in 2010 shows that people recover faster in natural surroundings. Although the mechanisms of stress reduction and enhancing well being are still discussed, the positive benefits of these quiet areas were reason for the European Commission and Parliament to require competent authorities to preserve these areas.

Article 8 of the Environmental Noise Directive requires that competent authorities delineate, preserve and manage quiet areas in and outside agglomerations. The exact definition of what should be considered a quiet area and what preservation and management should consist of, is left to the member states and their administrations. According to the directive a quiet area in an agglomeration is described as 'an area, delimited by the competent authority, for instance which is not exposed to a value of Lden or of another appropriate noise indicator greater than a certain value set by the member state, from any noise source.

A common misunderstanding is that the absence of noise automatically implies total silence. Experiences have however shown that people feel very uneasy and uncomfortable when they are in a soundless environment, such as an anechoic chamber. People need sounds, as these are meaningful and provide information about the surroundings, including the volume of a space and what activities take place in that space. Countless activities have their own sounds and as such provide the necessary information we, human beings, need to function in society.

Following the definitions provided in article 3 of the Environmental Noise Directive a quiet area is not intended to be silent, but undisturbed by unwanted or harmful outdoor sounds created by human activities or, in the terms of the directive, environmental noise. Quiet areas thus should be understood in terms of absence of sounds that interfere with activities people undertake in those areas. That is communication in all its subtle forms such as orientation and signals of upcoming danger. Or communication in direct forms such as speech and warning signals. And activities that are typical for quiet areas like city parks, such as thinking, reading, writing, sleeping and having lunch or picnic. It is this kind of activities that are known to be easily and frequently disturbed by noise, as has been reported by for example Stansfeld et al. in 2005 and the WHO in 2000 and 2011.

The evaluation of the implementation of the Environmental Noise Directive though showed that there is a large variety in approaches and methods for the identification of quiet areas. This concerns the physical as well as the effect oriented definitions and selection criteria that have been applied. Considering the directive's requirement on preservation and management of these areas, analysis of action plans showed that hardly any authority addressed quiet areas in their action plans. Many authorities and acoustic experts struggle with this new task concerning qualitative good acoustical environments; as the directive introduced a new scope in the traditional policy approach of noise abatement.

Interestingly, concepts and approaches of soundscape research are now considered as purely acoustic approaches seem to provide only half of the knowledge we are looking for when focussing on sounds and how they are perceived by humans. Soundscape research finds its basis in the work of Murray Schafer, a Canadian composer and environmentalist who started the World Soundscape Project in the late 1960s and 1970s at the Simon Fraser University. Schafer was concerned about the negative impact of noise pollution on our acoustic environment and established a team of researchers on soundscape studies. They collected sound samples all over the world, stored in databases where today's researchers still can find 'old' soundscapes not influenced by sounds of the 21st century. During the last decades Schafer and his colleagues work has been followed up by many academics.

Currently the COST Action on Soundscape and ISO Working Group 54 on Soundscape are main contributors to the research domain, specifically due to the methodological focus that is facilitated through the work of these both groups of researchers. A crucial step recently has been made in the preparation of an ISO definition for soundscape. Although one might think this an easy task, practice has shown that involving many researchers from a range of academic fields per definition results in long and strong discussions.

But...the definition proposed is as follows: soundscape is the perception and understanding of an acoustic environment, in context, by the individual, or by a society. Or the briefer proposed definition of soundscape is the acoustic environment as perceived, by people, in context.

The formulation of local noise policies, based upon soundscape principles, provides ample opportunities for improving environmental quality of cities and health of citizens. Unlike today's noise mitigation and abatement policies, the soundscape approach offers many non-acoustic options for local improvement. Politicians and other decision-makers at all administrative levels are willing to adopt this approach. The challenge or risk however is methodological; what criteria and variables to consider when defining and characterising areas and soundscape? The answer to this is still being sought; by academics, by the European Commission and its expert panel on noise, by experts working with regional and local administrations. Some thoughts and practices though are available and might be considered as preliminary recommendations on a methodology for soundscape research for quiet urban areas.

In general member states and decentralised authorities currently use four complementary methods for identifying quiet areas. Firstly, noise mapping by modelling various noise sources and calculate noise emission and immission levels. A second approach is measuring actual sound-pressure levels in-situ. These measurements can be short 15 minutes long measurements at various spots of the studied area or by way of soundwalks. Or unmanned measurements during longer periods of days, weeks or even months. Thirdly, in a field survey users and visitors of the quiet area are interviewed regarding their evaluation of the area and the soundscape. And finally, experts are involved in the assessment of the quiet area.

What are the benefits and limitations of these approaches? Noise maps often are used to identify areas that are not exposed to calculated sound-pressure levels from environmental noise above a given threshold. The maps provide an easy to interpret visual representation of average noise levels due to various sources, such as traffic. One should however realize that the accuracy of maps is highly dependent on the quality of the input data and the model used. The resulting noise map might thus be limitedly representative for the existing acoustic climate of the quiet area. In addition, noise maps typically present calculated A-weighted sound-pressure levels. Research for example from Nilsson in 2007 showed that these values do not provide an accurate representation of how people perceive the acoustic environment, not even with regards to loudness. Sound provides a lot more information to human beings than just magnitude.

Recognising these limitations or nuances to noise maps, actual noise levels are measured in-situ. These measurements are typically used to complement or to validate the noise maps. The advantage of measuring is that they provide the actual sound-pressure levels at a given place at a given time. They may better reflect reality than models and calculations, for example as all sound sources are measured and not just environmental noise such as cars and industry. Limitations to this approach are that measurements are time-consuming, labour intensive and costly. And, even more critical, measurements cannot distinguish sound-pressure levels from different sources, which is specifically problematic in unmanned long-term measuring. Sound- and sound-source recognition is critical in soundscape research, specifically in quiet areas. As sounds of people, wind in vegetation and flowing water are known to be statistically significant explanants for positive perception of a quiet area's soundscape.

Main reasons for preserving good acoustic environments is that they enhance restoration and stress reduction of our citizens. These mechanisms are only partially explained by acoustic factors, and thus research into psychological parameters is needed. This is where knowledge, experience and methods from soundscape research enter the domains of physics and acoustics. In order to understand humans in relation to soundscape, the experiences of users of the quiet areas have to be evaluated. Such studies may include, but are not limited to, perception of how dominant different sound sources are, how acoustic quality is perceived or appreciated, what sounds are appropriate for the place, and the use of the area. In contrast to sound-level meters, human beings can distinguish the intensity of sounds from different sound sources, such as technological sounds, humans and nature. This categorisation of sound sources has been developed and applied by for example Nilsson, Axelsson, Berglund and other scholars. And has proven to work well, as I will illustrate later with an example from Rotterdam.

A remark should be made here. We, human beings, have a multitude of senses. Sight, hearing, taste, smell and touch, are the five traditionally recognized senses or perception modes. Soundscape research showed that perceived acoustic quality is not limited to the acoustic environment per se, but also influenced by the visual quality of an area. A green, nature environment may increase perceived acoustic quality and reduce annoyance. Even though trees, bushes and other green features have a limited influence on sound-pressure levels. No technical devices are able to measure this effect, and once again, people have to be questioned on their appreciation and evaluation of the area. There are however some disadvantages to field surveys, which are, similar to noise measurements, rather time consuming, labour intensive and costly. Specifically when aiming at statistically significant analyses and correlations a relatively large random sample has to be guaranteed. Another limitation is the still limited expertise in behavioural science at local administrative and even national ministerial level, in order to develop appropriate questionnaires. As no standardised methods and instruments exist linking acoustic to psychological data is critical and mistakes or misinterpretations will easily occur. COST Action on Soundscape and ISO Working Group 54 on Soundscape are currently working on standardised methods in order to fill this methodological gap.

Finally, the fourth approach consists of using experts in soundscape research. As mentioned before, the identification of quiet areas by sound-pressure levels solely is limited and should be complemented with other non-acoustic factors, based upon land-use plans, cultural heritage, ecological values, recreational and social values, and accessibility. For this reason other experts like architects, ecologists, sociologists will have a great contribution to the acoustic experts. Compared to the other three mentioned approaches this method even less practical experience or instruments are available.

In order to illustrate some practical experience with soundscape research in quiet parks, I will continue this lecture with some examples stemming from my research in parks in Rotterdam and nature areas in the province of South-Holland. Detailed information can be found in the proceedings of this conference and other recent international noise congresses. The main focus in the remainder of my lecture will be on evaluating human perception, but not after I have presented some results in line with the first two steps of the before presented approach. To recall, these steps are the identification of quiet areas using noise maps and evaluation of the acoustic quality through noise measurements.

The strategic noise maps visualize noise levels above 55 dB Lden, for separate noise sources as well as cumulative noise levels. Areas which have noise levels lower than 55 dB Lden might be considered quiet areas, but knowledge of the city's layout and spatial outline is needed to limit and focus this selection process.

As the European Environmental Noise Directive only requires to map noise levels from 55 dB Lden and higher, we miss considerable data of areas where noise levels are lower than 55 dB Lden. And specifically there areas are of interest when we want to research the quiet areas. The European Commission Working Group Assessment of Exposure to Noise for example proposed some criteria for acoustic qualities in urban quiet areas. The Lday criteria for these areas are as low as 40 to 50 dB; which are noise levels and areas that are not always easily identifiable from the noise maps.

Taking the noise measurement results in Rotterdam into account, we must acknowledge that existing noise levels in quiet urban areas are higher than these various quality criteria proposed by the European Commission's working group or other studies. Measured noise levels in the three studied parks were between 54 and 58 dB Lday.

Although various noise indicators have been applied in studies in quiet areas, the most appropriate indicator for this type of research in addition to Lden or Lday seem to be LA50 and L1sec, max. According to for example Nilsson and Botteldoorn & de Coensel, LA50 as indicator for background noise describes fairly well the acoustic environment. In addition, sound events should be taken into consideration, as short, abrupt changes in some sound sources will probably be noticed by humans. In case of many sound events, the evaluation of the acoustic environment will be different from areas or periods of the day where only a few sound events are audible. Therefore L1sec, max or for example LA10-LA90 for dynamics in sounds should be determined as well.

The Rotterdam study showed that both LA50 and LA10-LA90 correlate well with the descriptions of the soundscape given by the people that were interviewed. Using verbal descriptions of soundscape qualities, defined by Berglund et al., statistically significant relations were found. For example the 10 dB difference between LA10 and LA90 in the largest park studied, correlated strongly with the word 'eventful' for soundscape quality.

The main challenges in quiet area research though lies in the psychological parameters, and relating acoustic and non-acoustic parameters which is even more challenging. Honestly, I and many others have not yet addressed that gap of linking human senses. This research domain in my opinion is still in its infancy and I am eager to learn more from future academic research. However, steps have been made with regards to questioning users of quiet areas on their evaluation of soundscape and landscape. To finish this lecture some practical reflections on developing a questionnaire. Pairs of words describing soundscapes are very helpful in field surveying. One should however carefully select the words and contrasting pairs, in order to obtain relevant data. The figure on the sheet illustrates this delicacy, where three word pairs have a strong negative correlation, and as such are strong pairs of verbal descriptions. In addition, the verbatim have high descriptive value, as can be concluded from the length of the lines. The longer the line, the more descriptive the question or variable is. Strong pairs are uneventful and eventful; annoying and pleasant; and chaotic and calm. Whereas, monotonous and exciting are not negatively correlated, as can be read from the 90 degree angle in the picture. Both words are thus not understood by the people that were interviewed as contrasts. An explanation might be the sexual connotation given to the Dutch translation of the word exciting. This means that part of the interview data is not valid and had to be left out of the analyses. And this means we have to define a different word pair and assess whether we can increase data quality.

Many other methodological examples and challenges could be illustrated. But as my main aim and ambition is to further research in quiet areas, improve quality of life in cities and health of our citizens, I want to conclude this lecture with an invitation to all participants of this conference in sharing ideas, lessons-learned and methods developed. During the next days we are in Nis as peers, colleagues, *primi interparis* and I hope to have the opportunity to discuss our mutual interests. We will have ample opportunities, during the sessions, coffee breaks, and once we are back home. And may I finalize my talk with thanking Prof. Prascevic and his colleagues for inviting me to this conference and you participants for listening to this not so acoustic topic of quiet area research.