TASTE: search for new indicators for acoustic and environmental quality of urban areas

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ABSTRACT

Within the TASTE project (Towards Acoustic Sustainable Environment), urban areas of good acoustic climate and other environmental qualities are studied with the aim of providing new insights in citizens' perceptions of these areas that can be related to suitable indicators, optimized for urban noise policy. The traditional approach in many countries is to limit noise exposure at facades, and as such to minimize noise annoyance and other adverse health effects. Noise legislation has been effective in counteracting and balancing the significant increase in economic activities, mobility, and population. However, despite large efforts and budgets spent on for example noise barriers and insulation of dwellings, the percentage population being annoyed by noise from traffic has not decreased. The effectiveness of current policy instruments could be strengthened by providing 'areas of refuge'. These are urban areas where noise levels are relatively low and other environmental qualities support relaxation and physical activity that can compensate or reduce stress from too much noise at home. To this aim common noise indicators L_{den} and L_{night}, which are excellent for rating local noise levels, do not fully support optimal urban acoustical planning. Extended, spatial noise quality indicators, including sound(scape), perception and other environmental aspects, are needed. This topic is currently studied within the TASTE project, using triangulation of data from noise maps and measurements, spatial assessments and field surveys.

INTRODUCTION

As in many densely populated countries, noise exposure levels and percentages of noise annoyed population in the Netherlands have been stable since decades. Considering the significant increase of, for example, traffic, economic activities and population, the stabilisation within the noise policy domain is positively assessed. However, adverse health effects due to long term exposure to noise from road and railway traffic, aviation and industrial activities are significant. And in contrast to other environmental health stressors, such as asbestos, particulate matter and nitrogen oxide, we do not witness decreasing trends. The traditional noise abatement approach today is ever more experienced as moderately effective in reducing adverse health effects and cities need other policy instruments and integrated approaches (Weber 2013).

Noise abatement measures often are infeasible, e.g. noise barriers in densely built urban areas are technically and visually unaccepted. In addition to high costs of e.g. insulation of facades of dwellings, stringent noise source emission regulation is not expected for the next decades due to political and societal discussions at European Council and Parliament level and the lobby by the industry sector targeted. Complementary approaches, however, could strengthen the existing noise policy instruments mix in a (cost-)effective way. One promising idea is to enhance urban planning through creating and protecting outdoor spaces in urban areas with a high acoustic quality. Such relatively quiet, high (nature) quality areas within acceptable travel range (by foot and/or bike) can offer 'refuge' from environmental stressors within citizens' dwellings and neighbourhood. Studies suggest that spending time in 'green' areas with relatively low levels of environmental noise is beneficial for public health and well-being (e.g. Kaplan 1995, HCN 2006, Alvarsson 2010). In other words, specific areas provide the acoustic environment that doesn't interfere with or disturb specific human processes like thinking, reading, communicating, resting and sleeping (e.g. Stansfeld et al. 2005, WHO 2000, WHO 2011).

An interesting approach, thus, is considering (natural) sounds as a common good ('goods' or 'resources'), contrasting it with noise pollution ('bads' or 'waste'). The two approaches are illustrated in Table 1 below from Brown (2012).

Table 1: Two approaches in 'sound' policy research

Environmental noise management approach	**Soundscape approach**
Sound managed as 'a waste'	Sound perceived as 'a resource'
Focus is on sounds as discomfort	Focus is on sounds of preference

TASTE: A GENERAL INTRODUCTION

The main aim of the TASTE project (acronym for Towards Acoustic Sustainable Environment) is to understand the impact and key explanatory factors of urban areas with good acoustic qualities. In addition to a picture of noise exposure levels from environmental noise sources such as road, rail and aviation (so-called unwanted sounds), a better understanding is needed of 'wanted' sound sources and non-acoustic variables. The latter gained (academic) attention during the last decade, mainly due to the entering into force of the EU Environmental Noise Directive 2002/49/EC (commonly abbreviated END). The END requires competent authorities to draft strategic noise maps, implement noise action plans and to delineate and protect quiet areas. Article 8 END (p.15), for example, states that action plans for agglomerations with more than 250.000 inhabitants "shall also aim to protect quiet areas against an increase of noise". Annex V of END in addition, requires reports on actions or measures which competent authorities intend to take to preserve quiet areas, such as land-use planning, noise abatement measures and traffic management.

Practice shows that municipalities and member states are lagging behind, specifically in meeting the requirements on areas with good acoustic quality (Milieu 2010). An explanation could be the fact that a clear definition of quiet areas is missing and decision makers and society are not aware of the importance of such areas.

According to the directive a quiet area in an agglomeration 'shall mean an area, delimited by the competent authority, for instance, which is not exposed to a value of L_{den} or of another appropriate noise indicator greater than a certain value set by the Member State, from any noise source' (p.14). As a result a wide range of indicators is used within Europe; a comprehensive overview is provided by the QUADMAP state of the art report (Bartalucci et al. 2012), as well as the forthcoming Good Practice Guide of EEA. Secondly, delineating quiet areas on mechanical noise indicators ignores the fact that other factors are also relevant for the valuation and appreciation of these areas. The acoustical quality of 'quiet' areas thus is to be understood by a combination of both acoustic and other environmental, social and personal factors. This is in line with the acoustic and, in greater proportion, non-acoustic factors that explain noise annoyance (Job 1999), positive effects of (wanted) sounds and green.

Research focus and methodology

In TASTE we are trying to find answers to the following research questions:

- What makes people perceive a specific area as acoustically pleasant; which explanatory factors can be identified for the appreciation of visitors?
- Which (extended) noise indicators are appropriate predictors of visitors' perception and appreciation of acoustic environments, such as L_{den}, L_{day}, events/peaks, or soundscape?
- What tools or methods are needed for protecting and/or improving urban areas with good acoustic qualities?

The research is based upon a triangulation of data collection and analysis, such as surveys, desk studies, noise calculations and mapping, and noise measurements. The suggested (noise) indicators will be tested and improved.

The outline of this paper is as follows: the next section presents the results from a survey on the appreciation of acoustic quality of parks and on the home situation of citizens of Rotterdam, the Netherlands. The subsequent section briefly discusses the preliminary indicators developed within our research; in the final section some conclusions and future actions are described.

SURVEYING CITIZENS' APPRECIATION OF PARKS

In 2013 we set out a second survey in Rotterdam on various environmental issues, including noise and parks. The aim of the survey was to collect citizens' appreciation of parks and the key qualities attributed to them. In addition, questions on their home situation and noise annoyance were included. As in 2011 (Weber 2011), the survey was carried out by the Rotterdam Centre for Research and Statistics (COS) among approximately 3.600 inhabitants. The survey response rate was 36%, i.e. 1.290 citizens aged between 16 and 85 years answered the questions on noise annoyance and (quiet) urban parks. This section presents and briefly discusses the results as part of the TASTE research on the acoustic quality of urban areas.

Acoustic environment at home

Table 2 shows to which extent the respondents indicated that they were annoyed by different types of noise sources at their homes.

Table 2: Annoyance by various noise sources at home

# respondents	not at all	slightly	moderate	quite	very much
mopeds and (motor) scooters	35	36	17	8	5
road traffic	37	37	15	6	5
aircraft	68	20	8	3	1
low frequent / humming noise	69	17	8	3	3
events, peak noise	73	16	6	3	2
businesses / industry	85	9	4	2	1
trains	85	9	4	2	1
windturbines	98	1	1	0	0

In line with national surveys the main noise sources causing annoyance at home are mopeds, scooters and road traffic; both categories resulting in 25 – 30% of (highly) annoyed citizens. (Multi-) Annual noise annoyance surveys from, for example, CBS and RIVM illustrate that approximately 40% of the Dutch population since decades has been annoyed by noise from traffic noise (air, road and railway) and/or industrial activities (Van Kempen and Houthuijs 2008, Woudenberg and Van Kamp 2013, Weber 2013).

In addition, the acoustic quality outside respondents' homes was questioned (see Table 3 below).

Table 3: Acoustic quality outside dwelling

How do you perceive the acoustic quality of your backyard, balcony or patio?	% respondents
I do not have a backyard, balcony or patio	39%
Very good, I can comfortably relax here	30%
Moderate, also here I am annoyed by noise	25%
Poor, noise levels make me spend less time outside than I would prefer	6%

In other words, approximately 60% of the respondent has access to a backyard of whom 50% perceives the acoustic quality as very good, 41 % as moderate and 10% as poor.

Urban parks: visits and appreciation

In order to answer the research question on factors explanatory for perception and appreciation of parks, an example of urban areas with, in most cases, good acoustic quality, the survey comprised various questions on park visits. Similar to a previous survey in 2011 respondents were asked to mention the specific park, visited most frequent (Weber 2011). A change can be noted in the top-3 most visited parks in 2011 and 2013; see Table 4 presenting the ranking of all parks in 2011 and 2013, the average number of visits per respondent per year (2013), the appreciation of tranquillity, nature and recreation.

Table 4: Visits and appreciation of parks in Rotterdam

	Kralingse Bos	Euromast	Zuiderpark
ranking (2011)	1	3	2
ranking (2013)	1	2	3
# visits	20	15	36
score for tranquillity (averaged)	7	7	7.1
score nature value (averaged)	7.6	7.4	7.4
score recreational value (averaged)	7.3	6.8	6.9

Interestingly, though the Kralingse Bos ranks highest as most visited park in 2011 and 2013, the frequency of visits (i.e. 20 visits on average per year) is lower than the number of visits to the Zuiderpark (i.e. 36 visits). The appreciation of tranquillity and nature for both parks (as well as Euromast park) is similar; only the (averaged) recreational value of the Kralingse Bos (a small urban forest with large lake) is valued slightly higher. This factor, though, is not the most important factor regarding park quality according to the respondents, as is illustrated in Table 5.

Table 5: Importance of the factors nature, tranquillity and recreational functions

% respondents	very important	important	slightly important	not important
nature	55%	39%	4%	2%
tranquillity	47%	41%	9%	2%
recreational	31%	42%	20%	8%

Overall, citizens of Rotterdam deem all three questioned aspects important factors for visiting and appreciating urban parks. The most important factor is nature quality (91%), though both other factors score relatively high (88% resp. 73%).
A subsequent question is whether people visit parks or other (relatively) quiet and natural areas because of noise exposure in their home situation. Table 6 illustrates that more than one-third of the respondents has to cope with noise annoyance or noise exposure at their homes. Of which 75% indicates that a relatively quiet urban area within the vicinity helps them in coping and relaxing.

Table 6: Noise annoyance and coping effects of quiet urban areas

Do you frequently feel annoyed or stressed by noise in your home? And if so, do you feel that a visit to a park or nature area helps to cope and relax?	**% respondents**
I am not annoyed or stressed by noise in my home	58%
Yes, I come to rest and feel more relaxed once at home	14%
It helps, but not enough	10%
No, it does not help	18%

In sum, the survey underlined the need for complementary policy approaches and for preservation of urban areas with high acoustic quality and some other (non-acoustic) characteristics. In line with other studies, tranquillity (an acoustic, or rather soundscape factor) and nature features seem to be crucial factors in (explaining) perception and appreciation of such areas. Finally, recreational facilities specifically in (average sized and larger) parks are deemed important.

INDICATORS: EXPLAINING USERS' APPRECIATION

As mentioned above additional indicators are needed in order to complement today's noise abatement approaches, that are fit for explaining and – in due time – predicting the perception and appreciation of specific urban areas. Consequently, this indicator should be able to incorporate multiple environmental, acoustic and non-acoustic aspects. In our research we preliminary employ the following factors:

- average noise levels caused by environmental noise sources (such as road and railway traffic, airplanes and industrial activities) ;
- the accessibility of the area for nearby inhabitants;
- the presence of wanted or pleasant sounds (so-called nature or human sounds), that could enhance the perceived acoustic quality, such as birds, trees, water. These aspects are related to soundscape theory (Axelsson 2012);
- non-acoustic and environmental factors such as nature features, safety, facilities, cleanliness, visual variety.

Similar factors can be found in various studies of parks and green areas within and outside cities. For example, the forthcoming EEA Good Practice Guide for quiet urban areas (cf. END) provides a selection of criteria for quiet areas, such as acoustic indicators (L_{eq}, L_{den}, L_{95}, L_{day}), soundscape, function/use, distance from noise sources, and visual qualities. In addition, the LIFE+ financed QUADMAP project is developing methods and instruments for the identification, assessment and management of quiet urban areas (cf. END) as well, employing several approaches and factors (Weber 2014). Finally, an example from urban planning is provided by Van Herzele & Wiedemann (2003). Table 7 illustrates the key factors identified in these studies.

As can be understood from this overview multiple approaches are required in analysing the perception and appreciation of urban areas; a multidisciplinary study and triangulation of data are evident. In TASTE we propose several data collection methods, for example (i) spatial plans for the assessment of function and size, (ii) aerial photos for size and nature features, (iii) noise maps for environmental noise sources and noise levels as well as distance to residential areas, (iv) noise measurements for sound levels. Currently a possible indicator for the acoustic quality of urban areas, the so-called Group Quality Level, is assessed within the TASTE research. This indicator aims to comprise some of the most relevant, explanatory factors presented above and in addition takes into account the number of inhabitants that has access to a quiet area. In the near future a comprehensive peer reviewed article is foreseen, discussing this indicator in detail.

Table 7: overview of factors applied for research of (quiet) urban areas

Factors	**EEA Good Practice Guide**	**QUADMAP**	**Van Herzele & Wiedemann**
Nature	n.a.	Green features, water features	Diversity, sustainability, natural character
Culture, history	n.a.	n.a.	Relicts of landscape history, degree of cultivation
Soundscape	Perceived acoustic quality/appreciation	Perceived acoustic quality/appreciation	n.a.
Environmental noise	Noise levels from environmental noise sources	Proximity to environmental noise sources, noise levels, options for noise abatement interventions	Environmental noise sources, noise levels
Facilities	n.a.	Equipment and other facilities	Entries, paths
Space	Size	Context or surroundings	Fragmentation, context or surroundings
Function	Recreation, nature protection, health protection/restoration	Recreation, nature, relaxation, walking through	n.a.
Distance	From motorways, and from cities/residential areas	Proximity to residential areas, accessibility	Accessibility
Visual	Areas with established values (documented in plans)	Perceived visual quality/appreciation	n.a.
Other	n.a.	Cleanliness, maintenance, safety, number of users	n.a.

CONCLUSIONS AND FUTURE ACTIONS

As discussed above indicators and methods regarding the perception and appreciation of urban areas with specific (acoustic and other) qualities are paramount for new, complementary policy approaches. This challenge is currently addressed in several research projects at international level, mainly within the academic work on soundscape. Multidisciplinary approaches are needed, as humans perceive their environment in a complex, multi sensorial and experience-based way. As a consequence new assessment methods are called for that comprise a wide range of explanatory factors, both acoustic and non-acoustic (in the traditional 'noise abatement terminologies'). This paper presented results in studying the appreciation of visitors of urban parks, from which the environmental quality and accessibility of outdoor green urban areas, appear highly important. Based upon the data collected

in Rotterdam, Amsterdam and Arnhem the research currently is assessing various indicators developed for urban areas with good acoustic and environmental qualities, such as the briefly introduced Group Quality Level. Results will be published during the next months.

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