

Socio-acoustic survey and soundscape analysis in urban parks in Rome

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INTRODUCTION

The Directive 2002/49/EC of the European Parliament and of the Council relating to the assessment and management of environmental noise and the Italian decree of transposition D.Lgs. 194/2005 introduce the concept of "quiet areas", either in agglomeration or in open country. Unfortunately, metrological criteria to identify such areas have not been defined yet, mainly due to the lack of knowledge of the effect of noise on their perceived soundscape quality (Nilsson 2007).

Several studies carried out over the last decade have shown that it's more realistic and useful an approach aimed to analyze the perception of the acoustic quality of the environment, rather than using noise indicators describing the sound environment only, i.e. the equivalent sound pressure level (L_{Aeq}) or the day-evening-night level (L_{den}) (Schulte-Fortkamp & Dubois 2006; Brown 2006; Kang 2007).

The importance of "quiet areas", or even better "areas of high acoustic quality" (Brown 2006), is widely recognized as they provide, at least temporarily, opportunities for relaxation and stress recovery from noise pollution to which the population is exposed in the everyday life. This health-promoting function should be preserved and improved, especially for the urban parks, as they can be easily accessed by the users but, meanwhile, are often surrounded by noisy areas due to the sound emission of road traffic, industries and other sources.

This paper describes a socio-acoustic survey carried out in three urban parks in Rome aimed to investigate the users' perception of the acoustic quality in the parks and its relationship with some acoustic parameters. The study is the first one in the urban green areas in Rome having structure and methodology comparable with the previous surveys carried out in urban parks in Naples and Milan (Brambilla et al. 2006). A preliminary survey on the web was performed to provide information useful to design the questionnaire to be used in the field survey and to identify the areas to be investigated. The in situ surveys were carried out taking binaural recordings of the sound environment and simultaneous interviews to people in the park. The results of the surveys have been related to the acoustic data determined from the recordings.

SELECTION OF THE URBAN PARKS

A preliminary survey was performed to identify the most frequented urban parks in Rome and to assess other aspects of these areas. In order to reach quickly an adequate number of participants, the survey was carried out on the web by a questionnaire containing 15 questions and proposed for filling in by e-mail to people living in

the municipality of Rome. The questionnaire was available on the web for 15 days in May 2010 and 121 persons answered to it.

The questions dealt with the most frequented green areas, the most pleasant and unpleasant ones, the reason for going to the park, the degree of satisfaction of the sound environment and of the area considering all its aspects.

Based on the outcomes of this poll, the urban parks of Villa Pamphili, Villa Borghese and Parco della Caffarella were selected for the field survey. Figure 1 reports the percentages of respondents for the 5 degrees of satisfaction of the sound environment and of the area considering all its aspects. The dashed line represents equal percentage of respondents satisfied equally by the sound environment and all the aspects of the area.

In the selected three parks preliminary surveys were carried out to identify the zones most frequented by people and of different use (children's play areas, paths for sport activities, etc.).

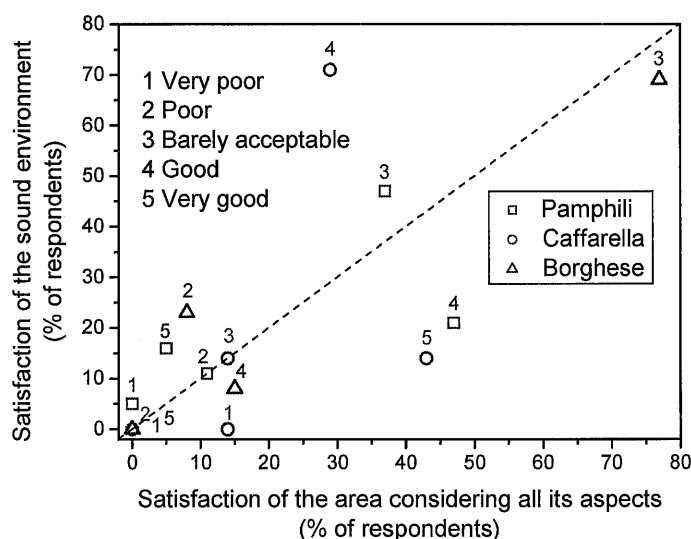


Figure 1: Degree of satisfaction of the three green areas

Features of the urban parks

The three urban parks chosen for the study are situated inside the agglomeration of Rome and show different features, i.e. the presence of historical, monumental and natural elements.

Villa Borghese (about 80 hectares) is surely one of the most famous parks of Rome and Italy. It is enriched by the presence of historical and architectural buildings and, therefore, it is frequented by many tourists and often used for exhibitions and concerts. The sound environment is characterized by anthropic sounds and traffic noise from the vehicles passing on the streets surrounding and crossing the park.

Villa Pamphili (180 hectares) is one of the best preserved parks: the main change from the past is a busy road that divides the area into two parts. There are natural zones, not easily accessible and therefore less visited, while the areas close to the entrances of the park are the most used. There are a bar, two playgrounds, a location for sports facilities, a large area for dogs.

Covering over 190 hectares, Parco della Caffarella owes its cultural and historical feature to its location, close to two main ancient roads: Via Appia Antica and Via Latina. Its structure differs from the other parks and it shows mainly natural features. It is a neighborhood park, usually frequented by the residents in the area, mainly for jogging, cycling, and there are play areas for kids. Natural sounds prevail even if aircraft noise is perceived due to the fly-overs from/to Ciampino airport.

IN SITU SURVEYS

The sound environment in each of the three parks was recorded binaurally in fixed positions distributed in the areas, rather than during soundwalks. The recordings were made for periods of about 5 minutes, using binaural headphones worn by the operator and connected to a digital audio recorder. During the recordings sound sources and noticeable sound events were pointed out by the observer.

Face to face interviews were carried out simultaneously with the sound recordings by means of a questionnaire adapted from that used in the preliminary on-line poll. The questions dealt with details of the presence in the park (frequency, days, hours and average time of attendance), means to reach the area (car, public transport, bicycle, etc), the main reason for attending the park, the degree of satisfaction of the area as a whole and of its sound environment. In addition, the assessment of 20 aspects of the area, expressed by a score on a scale from 1 (very poor) to 10 (very good), was collected together with the interviewee's personal information (age, educational level, occupation, etc.) and the indication of her/his most frequented areas or paths in the park.

Table 1 reports the number of binaural recordings and interviews carried out in the three parks.

Table 1: Binaural recordings and interviews carried out in the three parks

Park	N. of recordings	N. of interviews
Villa Borghese	30	88
Villa Pamphili	31	79
Parco Caffarella	24	61
Total	85	228

RESULTS AND DISCUSSION

The analysis of the 228 interviews shows that sounds from nature are the most perceived and desired, as shown in the frequency distribution plot in Figure 2.

Considering all the opinions expressed on the 20 aspects of the three urban parks, the presence of trees (average score 8.2) and tranquility (average score 8.0) were rated better than natural sounds (average score 7.7) and silence (average score 7.6), as shown in Figure 3.

Pooling the respondents rating "good" and "very good" the sound environment in the three parks, a 74 % value was obtained, a bit lower than the threshold of 80 % established by the Swedish Environmental Protection Agency (2005) to identify a "quiet area". Figure 4 shows that 27 % of respondents rated the quality of the area considering all its aspects better than its sound environment and 30 % reacted contrariwise.

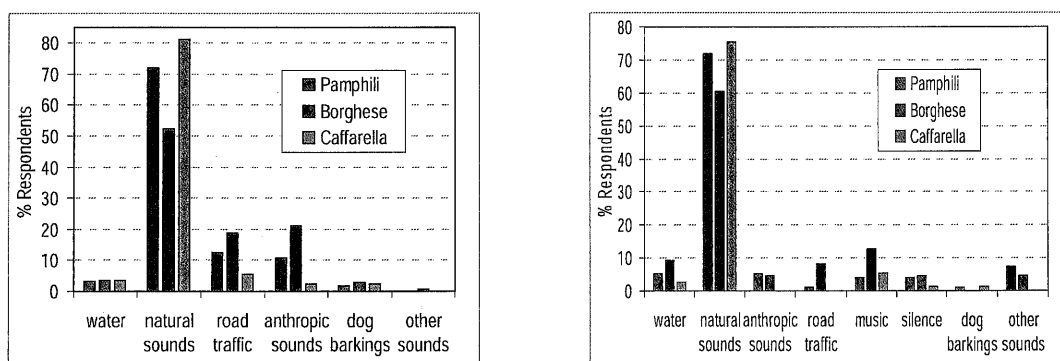


Figure 2: Sounds perceived (left) and desired (right) in the three parks

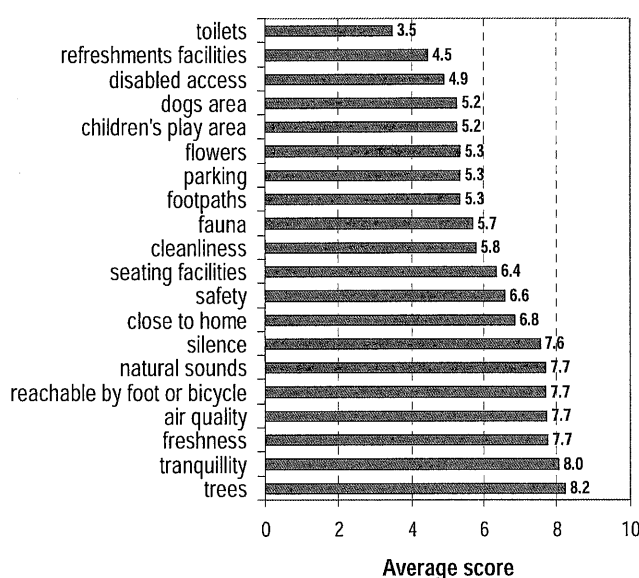


Figure 3: Rating of the various aspects of the parks (from 1=very poor to 10=very good)

It is known that personal expectation and experience form a contributory factor in the perception of soundscapes (Bruce et al. 2009) and to evaluate this aspect the responses on the sounds considered desirable to be heard in the park have been compared with those on the sounds actually perceived in the park. Figure 5 confirms once more that natural sounds are often perceived and desired, whereas traffic noise and voices are more frequently perceived than desired.

The binaural recordings of the sound environment have been analyzed to determine several noise parameters, i.e. L_{Aeq} , L_{An} , the unweighted spectrum centre of gravity G (Grey & Gordon 1978), observed as a good measure for the degree of pollution of the soundscape with traffic noise (De Coensel & Botteldooren 2006), the number of sound events exceeding L_{A50} by 3 dBA and L_{A95} by 10 dBA, as well as psychoacoustic descriptors more related to the sound perception (loudness, sharpness, roughness and fluctuation strength). Before such analysis, unusual sound events that might affect the measures have been eliminated in the calculation of sound descriptors.

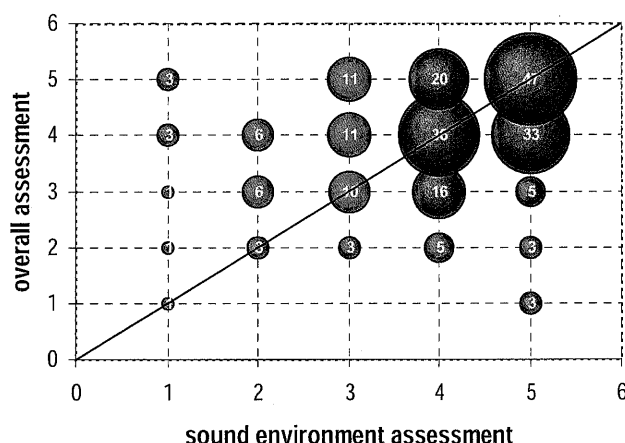


Figure 4: Overall assessment of the area vs. its sound environment for the three parks

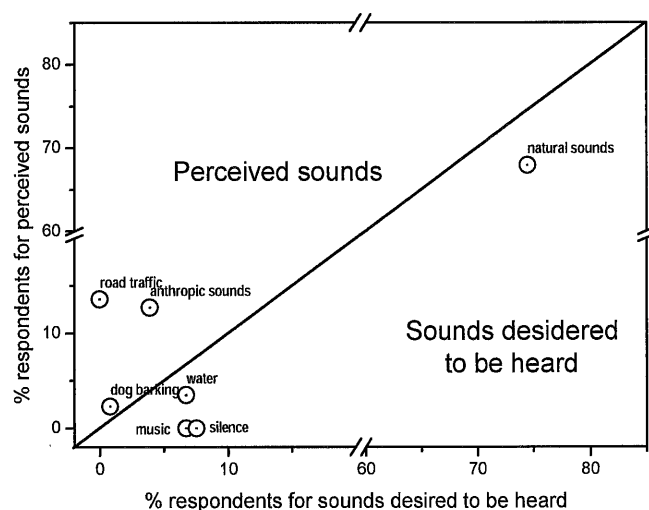


Figure 5: Comparison of sounds perceived and desired to be heard in the three parks

The distribution of the L_{Aeq} values in the three parks is reported in the box plot in Figure 6. The white triangle is the median value and the red line at 50 dBA is the noise limit for day-time (06-22 h) established by the Italian legislation for the most sensitive areas of acoustic zoning, parks included. The average values observed in Villa Borghese and Villa Pamphili exceed the limit by 5-6 dBA. Despite this, approximately 70 % of respondents in both areas have expressed a positive rating on the sound environment. A better situation was observed in Parco della Caffarella where the average value of L_{Aeq} is about 50 dBA, and this is confirmed by the higher satisfaction of users (87 %) of the sound environment. The smallest variability is observed in the data taken in Villa Borghese (interquartile 3.4 dBA), whereas larger (interquartile from 6.6 to 7.6) is the variability obtained for Parco della Caffarella and Villa Pamphili respectively. These differences in the L_{Aeq} variability are likely due to the different type of sound sources in the three parks: in Villa Borghese anthropogenic sounds are predominant, whereas natural sounds prevail in Parco della Caffarella and Villa Pamphili shows a mixture of both sound sources.

Figure 7 shows the L_{A50} values plotted versus the unweighted spectrum centre of gravity ($\lg G$). Three areas can be identified, namely area 1 for $L_{A50} < 50$ dB where 75 % of sites monitored in Parco della Caffarella are included, area 2 identified by $L_{A50} > 50$ dB and $\lg G > 2.1$ containing 61 % of sites monitored in Villa Pamphili and area 3 delimited by $L_{A50} > 50$ dB and $\lg G < 2.1$ where 77 % of sites monitored in Villa Borghese are included.

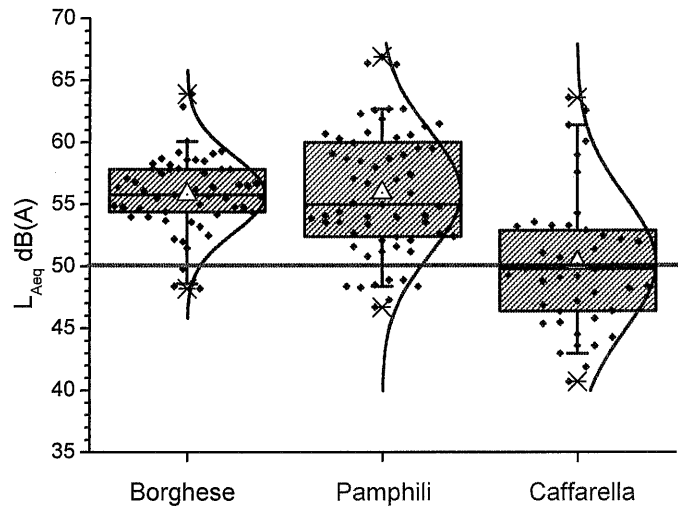


Figure 6: Distribution of the L_{Aeq} values in the three parks

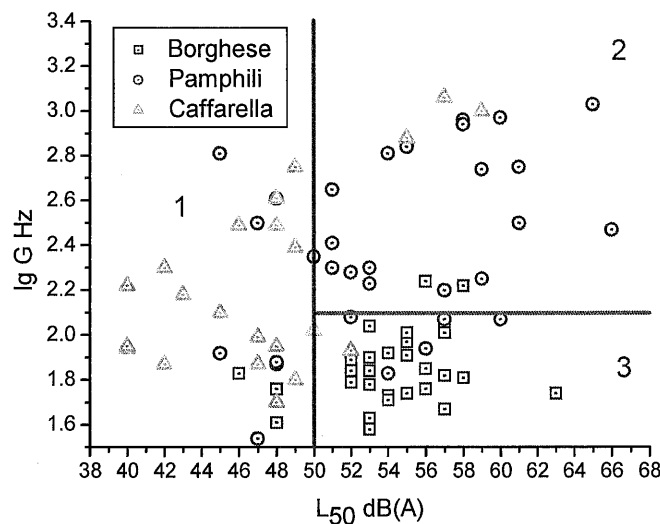


Figure 7: Values of L_{A50} plotted versus the unweighted spectrum centre of gravity ($\lg G$)

A preliminary attempt to summarize the data and to show them in order to be easily understood is given in Figure 8, reporting the aerial view of Villa Borghese together with the acoustic data given in the legend. In particular the box, placed at the position where the audio recording was taken, is red when $L_{Aeq} > 51$ dBA, yellow for L_{Aeq} between 49 and 51 dBA and green for $L_{Aeq} < 49$ dBA.

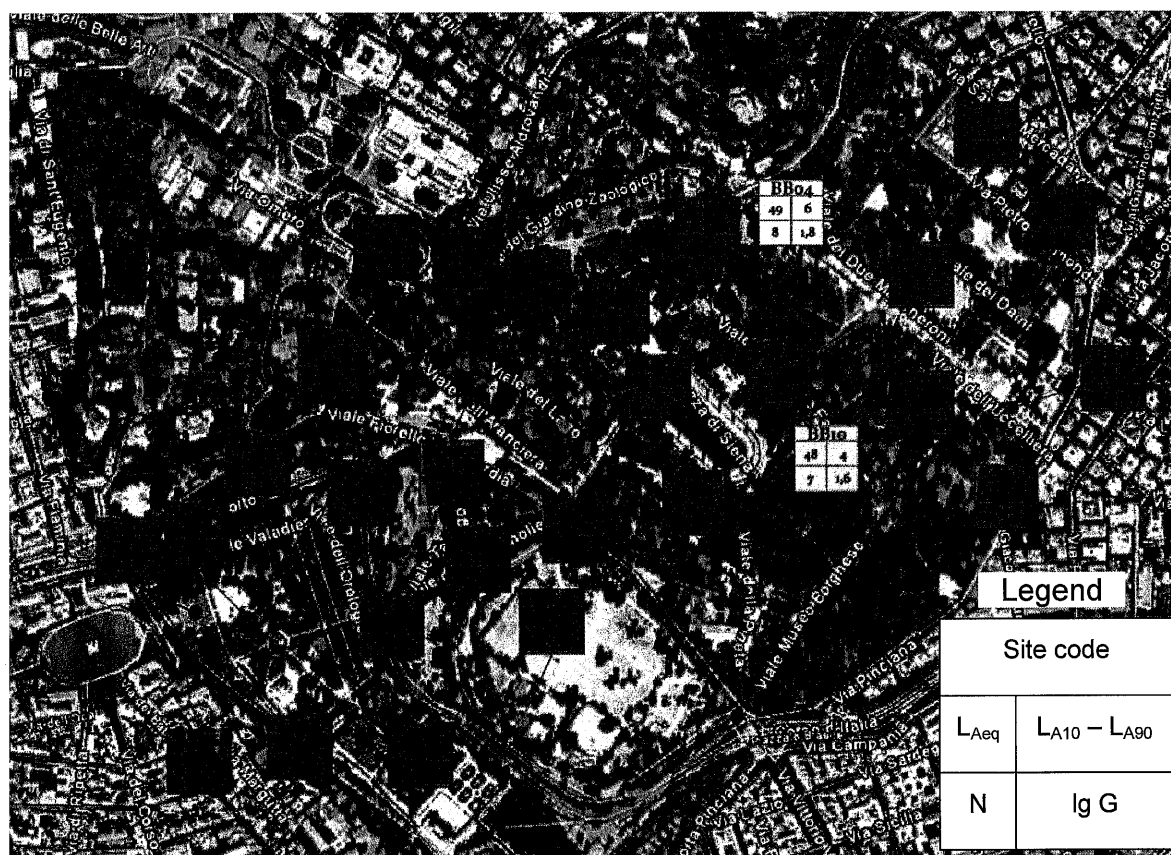


Figure 8: Aerial view of Villa Borghese with the main acoustic data

CONCLUSIONS

The analysis of the data collected in the field survey, involving 228 users of the three urban parks, shows that the sound environment is perceived as good (34 %) and very good (40 %). However, the three areas should not be considered quiet as in most of the sites the value $L_{Aeq} = 50$ dBA is exceeded (Nilsson & Berglund 2006). This value is also the noise limit established by the acoustic zone plan for sensitive areas and, therefore, noise mitigation actions should be undertaken, at least for Villa Borghese and Villa Pamphili. On the other hand, as said before, users seem to appreciate both the sound environment and the general conditions of the park.

This discrepancy clearly shows that the classical approach based exclusively on the use of the A-weighted equivalent sound pressure level is not sufficient to describe the quality of a sound environment, but it is necessary to consider other psychoacoustic parameters (loudness, etc.) and descriptors in the time-domain (percentile levels) and frequency (center of gravity of the spectrum). Moreover, the noise limits issued by the legislation so far are aimed to reduce the harmful effects of noise on health and, likely, would not be suitable for areas fulfilling a recovery and health-promoting function as the urban park should accomplish. In such areas the importance of subjective aspects, such as expectation and motivation, are crucial and they should be taken into account for their preservation and improvement.

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