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Urban and quiet areas soundscape preservation

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Abstract

In the last 10 years, worldwide acousticians have been involved in defining new multidisciplinary approaches which integrate contextual and subjective variables for the definition of the sound environment of urban, suburban and rural areas. These approaches take origin from the Soundscape concept, namely the way in which the environment is perceived and accepted by an individual and a community. One general idea is to shift from environmental noise control as a pure reduction of decibel related to annoyance studies for specific areas to the a more complete concept of sound quality of urban, suburban and rural areas and to classify such sound quality as a cultural heritage to preserve and/or to restore. These approaches can lead to new experiences in which the sound quality can become a resource for the community in the same way the “sightseeing” in cities or in natural parks is nowadays. Although many studies have been conducted and there is a demand of new standardization, Soundscape approaches and analysis need further investigation which will get strength only from field applications, projects and results in different contexts. An overview of recent studies for the preservation of the Soundscape in urban and quiet areas is presented.

Resumen

En los últimos 10 años, los acústicos de todo el mundo han estado involucrados en definir nuevos y multidisciplinarios planteamientos, integrando variables contextuales y subjetivas, para definir el ambiente sonoro de las áreas urbanas, periurbanas y rurales. Estos planteamientos han dado lugar al concepto de “Paisaje sonoro”, denominando así la forma en la que el medioambiente es percibido y aceptado por el individuo y la comunidad. La idea general es pasar de un planteamiento de control del ruido basado en la pura reducción de decibelios relacionados con los estudios de molestia en áreas específicas, al concepto más completo de calidad sonora de las áreas urbanas, periurbanas y rurales y considerar esta calidad sonora como una herencia cultural que se debe de proteger y/o restaurar. Estos planteamientos pueden conducir a nuevas experiencias en las que la calidad sonora puede llegar a ser una fuente de ingresos para la comunidad de la misma forma que actualmente son las “visitas turísticas” en las ciudades y parques. Aunque se han realizado muchos estudios y existe una gran demanda de normalización, los estudios y análisis del Paisaje sonoro necesitan de nuevas investigaciones que refuercen los campos de aplicaciones, proyectos y resultados en diferentes contextos. En esta conferencia se presenta una visión general de los recientes estudios para la protección del paisaje sonoro en las áreas urbanas y silenciosas.

1 Introduction

For centuries human beings have been forced in perceiving the environment through the visual sense. Architects and urban planners have designed cities, spaces, buildings only to impress the visual aesthetics. The sound of a place has been poorly treated and primarily related to noise control matters, strictly connected with the advent of mechanical sounds.

Considering the negative effects of noise on human health and comfort (hearing impairment, speech interference, sleep disturbance, cardiovascular effects, learning and working performance reduction and annoyance responses) but also the social handicap with absenteeism at the workplace, increasing drug use, accidents and loss of property value, national and international guidelines and regulations have concentrated their efforts in defining limits to environmental sound. An example is the EU Directive Relating to the Assessment and Management of Environmental Noise [1]. According to it Member States of Europe will elaborate noise maps for major sources and cities and will propose action plans. Following this road-map all new projects (e.g. transport) will be assessed for their “noise impact” on the community in terms of energetic noise limits (L_{eq} , L_{den}).

On the other hand it is widely accepted that improved quality of life and people’s satisfaction of the sound environment is not strictly correlated to reducing sound levels; but the type of sound sources, the people expectations, and other factors, mainly non acoustic, play an important role. Further, nowadays, different questions cannot find a immediate answer following only the classical environmental noise approach. Are the sound created by church bells still “*a community sound which is unique or possess qualities which make it specially regarded or noticed by the people in that community*” [2] ? Can a city be identified also for its particular sounds and become tourist attractive [3]? Do some historical places preserve also the aural sensation as in the past [4]? Is always a park associated to a “quiet area” [5,7]? Can people recognizes places with regard to their sounds [8] ? Is the sonic expectation of a place a target of a new project?.....

Starting from the concept of “Soundscape” as defined by Schafer [9], “*the study of the effects of the acoustic environment on the physical responses or behavioural characteristics of creatures living within it*”, in the last decade researchers have expressed interests toward new approaches to the sound environment classification, restoration and design. These attempts, which should go along with the classical environmental noise approach, are based on multidisciplinary integration of different disciplines: anthropology, architecture, ecology, design, human geography, linguistics, medicine, noise control engineering, psychology, sociology, and more recently computer simulation and artificial intelligence. They integrate contextual and subjective variables and consider Soundscape as a resource rather than a waste.

The research activity in Soundscape at national and international level has been intensive with presence in many European Research Framework Projects, papers published on special issues of international papers on acoustics [10] and related topics, and organization of structured sessions at international congresses.

The explicit reference in the EU Directive to “quite areas” defined generically as “... *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 of a certain value set by the Member State, from any noise source*” lead to many specific researches and studies on characterization of Soundscape in rural and suburban areas [11]. Intensive research activity is also been performed specifically on urban Soundscape evaluation [10]. While the target for the next years should be the explicitation, comparison, and evaluation of methods and indices from the different scientific domains [12], the current research in Soundscape is however still at the

stage of describing and identifying the problems and it is not widely clear how to incorporate the great amount of data in the design process. Nevertheless first case studies of urban, suburban and rural areas design or restoration in which Soundscape approach has been or will be contemplated, are becoming more and more frequent.

In this paper are presented some projects in which the author has been involved.

2 Quiet areas

2.1 Urban parks' restoration

The city of Naples was involved in the restoration of 3 urban parks namely "Villa Comunale" located in a busy area in the city centre, the "Poggio" park on the Capodimonte hill very close (100 m) to a very busy motorway and "Villa Floridiana" on the Vomero hill [13]. Among other specific targets, the restoration design wanted to increase the pleasantness of the Soundscape of the urban parks and define priorities in the actions. The study started with classical noise measurements (time history of 100 ms L_{Aeq} and 1/3 octave band spectra), each lasting 15 minutes, taken in different sites inside and outside each park; during measurements the operator took note of the type of sources producing noise events clearly recognisable in the ambient noise.

During the noise measurements inside the parks, subjects nearby the microphone location were asked to fill in a questionnaire giving their ratings on different aspects of the park. This procedure to collect at the same time noise measurements and subjective ratings enables to match, as appropriately as possible, the subjective responses to the experienced sound exposure. The questionnaire collected personal information, motivations to visit the park, days of week preferred to stay in the park (weekdays or week-end), amount of time spent in the park and whether other urban parks are frequented or not. Two more questions dealt with the degree of satisfaction on different aspects of the park (vegetation, clean air, cleanliness, security, landscape, silence), one question regarding the annoyance produced by the above aspects, two questions to rate the subject's expectation to hear some sounds in the park (leave rustling, bird twittering, voices, road traffic, aircraft fly-over, dog barking, waterfall) and their elicited annoyance and, finally, one question on the overall acceptability of the park environment.

The acoustic data collected in the noise surveys showed rather high noise levels inside the three parks because of the noise of sound sources in the surroundings. In particular, the lowest ambient noise levels were observed inside "Villa Floridiana" ($L_{Aeq} = 52$ dB(A) and $L_{95} = 43$ dB(A) on average) even if the surroundings are very noisy ($L_{Aeq} = 70,4$ dB(A)) due to road traffic noise. The "Villa Comunale" has shown the highest ambient noise levels ($L_{Aeq} = 66$ dB(A) and $L_{95} = 60$ dB(A) on average). Noise from aircraft fly-overs has been observed in all the parks, with highest SEL levels in "Poggio" park (SEL = 85 dB(A) on average) and in "Villa Comunale" (SEL = 83 dB(A) on average).

The aspects reported by the subjects as the most important for the acceptability of the park are given in Fig. 1. Silence was rated very important by 57 % of subjects on average but for all the parks it was ranked the lowest important among the considered aspects.

Natural sounds was widely expected to be heard in the parks and the most expected was bird twittering. However, noise from aircraft fly-overs and road traffic are also mentioned by 21 % and 6 % of the subjects respectively. These two transport noises are rated very annoying by a large percentage of subjects (46 % for road traffic and 41 % for aircraft fly-over) most likely because they are the least expected to be heard in the park. Indeed, the subject's expectation to hear a sound in a specific environment, that is its congruence with the environment where it is heard, influences the corresponding annoyance. This relation has

Landscape preservation was the principal aim of national authorities. According to different policies applied already in the National Parks of the U.S.A, management of the National Park of Cilento was interested in preserving the Soundscape and supporting the idea that it is a cultural and environmental heritage.

The Soundscape study was conducted through different steps: 1) classification of the areas of the park in different categories mainly on basis of their vocation (natural, anthropic); 2) in each area sound registrations with the sound walk method for the identification of major sound sources and their energetic values 3) laboratory tests to investigate at which rate, in different areas, introducing non natural sounds the subjective perception of the Soundscape will be modified [13]; 4) preparation of specific guidelines to support Management of the Park during the design, renovation and maintenance works.

For step 2), among the several samples of binaural recordings of environmental sounds collected in the park, two sounds were chosen as representative of Soundscape in countryside, namely the stream of a torrent and bird twittering with light wind. In addition, binaural recordings of sounds from four types of sources were collected as representative of human activities (children voices), community noises (church bells) and technological noises (motorway and pass-by of a motorcycle and a car). These were processed at three different sound levels (0, -5 and -10 dB referred to their recording level) and mixed with each of the two countryside sounds to get 24 sound stimuli. An example of these stimuli is given in Fig. 3, reporting the 100 ms L_{Aeq} time history of vehicle pass-by noise mixed with the sound of the torrent stream. The two countryside sounds were also included in the list of sound samples asked to be rated by the subjects. For all the 26 sound stimuli the 100 ms L_{Aeq} time histories and the corresponding 1/3 octave spectra were determined for both ear channels. Acoustic parameters have been determined playing back the sound stimuli by the headphone assembled in the headset used for the binaural recordings put on the ears of a head-torso manikin and connected to a two-channels sound analysis system.

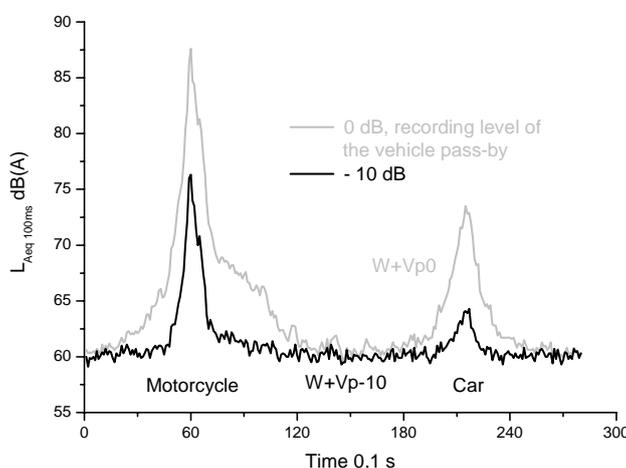


Figure 3. Example of the vehicle pass-by noise mixed with the sound of the torrent stream

The 26 sound stimuli have been played back in laboratory to a group of 26 subjects. During the listening session, lasting 30 minutes on average, a picture of a countryside (Fig. 4) was projected on a screen and the subject was requested to imagine to be present in such landscape while giving her/his rating to the items in the questionnaire after listening each sound stimulus.

Questions dealt with the acceptability of the sound, the influence of some sound sources on the acceptability of the entire sound sample, as well as in which extent the sound was congruent with the individual expectation of the Soundscape in a natural park.



Figure 4. Picture of the countryside shown to the subject during the listening session

As expected, the results obtained from the analysis of subjective ratings showed that the acceptability of the sound stimulus increases with the decrease of both overall level and detectability [14] of not natural sounds heard in the stimulus itself. This trend is shown in Fig. 5 by a bubble plot where the greater is the acceptability, the greater is the area of circles. The church bells resulted the most acceptable (78 % of subjects gave a score in the upper part (5-7) of the numerical scale ranging from 1 to 7), followed in decreasing order by children voices (44 %), vehicle pass-by (28 %) and motorway (24 %). These results point out the role played also by the type of sound source heard in the background sound on the acceptability of the overall sound. The more natural are the sounds, the more they are accepted in quiet areas.

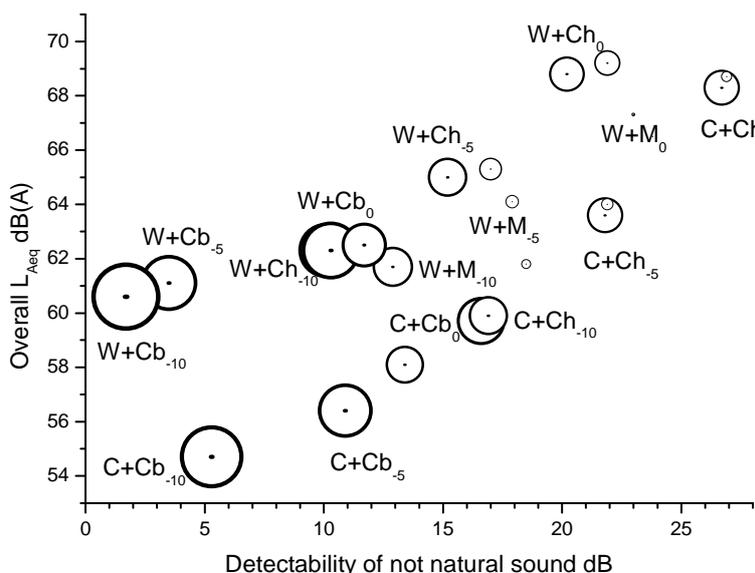


Figure 5. Acceptability of sounds plotted against their L_{Aeq} and detectability level of not natural sounds. W: torrent stream; C: countryside; Cb: church bells; M: motorway; Ch: children voices

Results of the laboratory tests were used to draw specific maps of the park in which are reported, for each hypothetical introduced sound source, its maximum sound level which will not modify the overall sensation and expectation of the population and of the users.

All these information will be used by Management of the Park to deal with the impact of new projects (e.g. new roads and other transport facilities) and support the final decision, but also to design the recover of large area to a sustainable tourism.

3 Urban areas

As all cities in *Magna Grecia*, the ancient Neapolis in Italy was built along three main parallel tight and straight streets (*decumani*) Fig.6. Since then and during next centuries, commercial and handicraft activities, but also social life, have been developed along these streets. The narrow ground rooms forced shopkeepers to occupy the main street to show their merchandises using vocal appeals to magnify their products and attract buyers and handicrafts to carry out directly on the street their job (hammering, sawing, etc.). Music artists had their performance on the streets. The Soundscape in the area was a strong symbol of the Neapolitan cultural identity [4].



Figure 6. View of the *decumani*

Nowadays *decumani* have kept main features of the past but some parts of them are overrun by vehicular traffic (red parts in Fig.7) while one other is only for pedestrians (green part in Fig.7).

The Municipality of Naples, considering the cultural heritage and high tourist impact of the area and before any action plan with new regulations, was interested in investigation on how noise (traffic, music outside shops, handicraft activities) has altered the Soundscape perception and cultural identity of the area.



Figure 7. Street investigated (red part motor vehicles allowed).

Sound walks with binaural recordings were registered during day and night time (Fig.8). A number of residents were interviewed and laboratory tests were conducted on people for subjective responses.

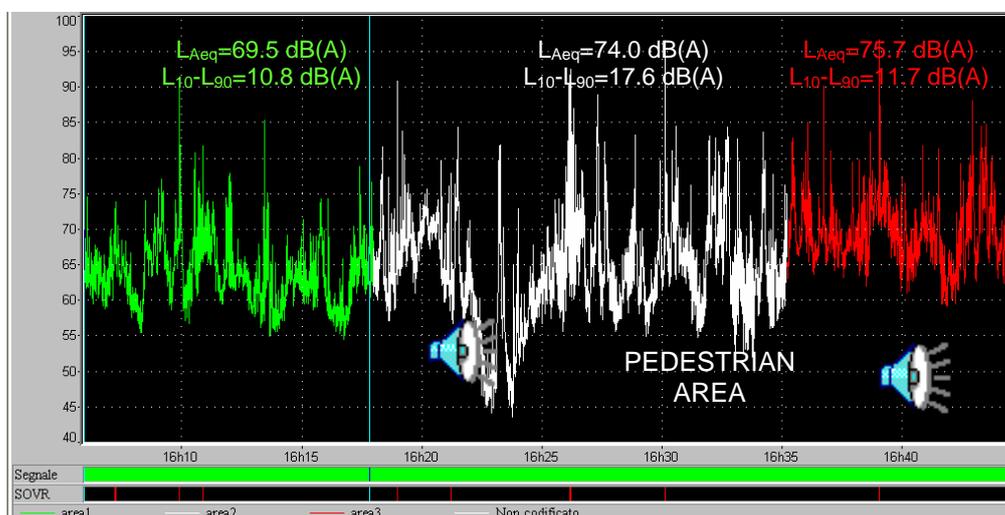


Figure 8. Soundwalk registration and sound levels along the street.

Although a congested urban environment and high sound levels were registered also in the “pedestrian” area, results of the interviews showed that 43 % of the resident population is highly annoyed by noise in the traffic area while, on the other side, almost 70 % of the interviewed people in the “pedestrian area” found the sound “pleasant”, expected and typical of this area. These results lead the Municipality to introduce more traffic restrictions but to allow, in the meantime, music and external handicraft activities along the streets.

3.1 Archeological sites

Pompeii is a worldwide famous large and busy archaeological area, visited by two millions of tourists every year. The Management of the archaeological site was interested in promoting new projects to increase the pleasantness of the site and make the tourist visit more enjoyable. Up to now few information are available on the Soundscape in outdoor archaeological areas, even if they attract and are visited by many people. These areas are interesting because their acoustic environment, formed by many sounds from tourists, from outside recreational and commercial activities and from traffic in the surrounding roads, can greatly interfere with the individual enjoyment of the area.

Noise surveys in selected positions inside and outside the site, sound walks, binaural recordings, on-site questionnaire survey for visitors and laboratory tests were performed [15]. The time histories of the sound pressure level recorded inside the archaeological area showed that many sources (natural and non natural) contribute to its acoustic environment. Among these sources voices from tourists are frequent in the most visited sites, while bird twittering, wind, road traffic and aircraft fly-overs are present in least visited sites and in those close to the borders of the archaeological area.

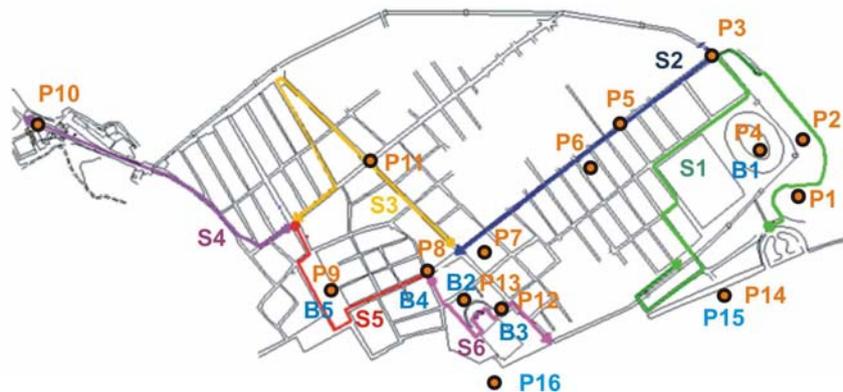


Figure 9. Selected positions for noise measurements (P), soundwalks (S) and binaural recordings (B)

The voices of tourists in the most visited sites rise the L_{Aeq} to an average value of 63.5 dB(A) and within a range of 17 dB (from 52 to 69 dB(A)). Values smaller of about 10 dB (average $L_{Aeq} = 53$ dB(A) and range from 46 to 60 dB(A)) are observed for the least visited sites.

Interviews showed that voices and natural sounds (bird twittering and wind) are the most expected sounds to be heard in the area and those least expected (from road traffic and aircraft fly-overs) are also the most annoying, as shown in Fig.10, confirming that the most is the expectation to hear a sound the less is the evoked annoyance.

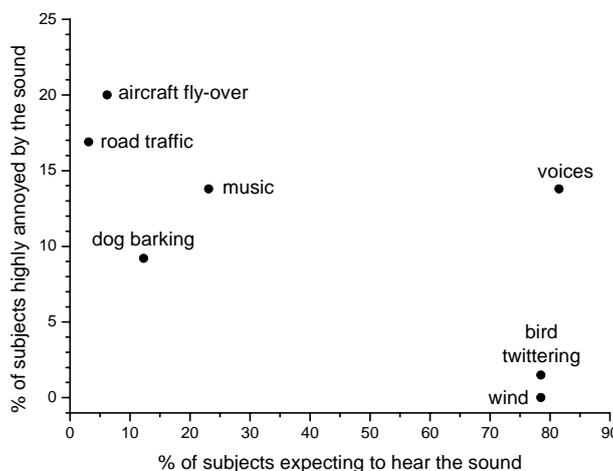


Figure 10. Percentage of subjects highly annoyed and auditory subjective expectation

The sound environment was rated good or very good by 50 % of subjects, while 81 % like the area much or very much. Most frequently subjects tended to rate more positively the overall quality of the area rather than its Soundscape.

All this information helped archaeological site management in design new organization and routes of the tourist visits (to avoid high concentration of tourists and voices in certain areas) and new features (reproduced sounds of old handcraft along some routes to cover traffic noise).

4 Conclusions

Although classical environmental noise surveys are useful to avoid the impact of new projects on population in terms of annoyance and health effects, the classification of rural and urban areas through the Soundscape approach, and its multidisciplinary studies, can involve more the population in the decision processes, can open new frontiers in designing spaces that fulfil population expectations, can help public management in final decisions. Soundscape approach is also important for preservation of the natural and/or cultural heritage of rural and urban areas.

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