The soundscape in cultural heritage

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Abstract. Soundscape analysis started to be a research field in the late sixties and received significant attention by researchers in the last twenty years. Experts in community noise and environmental acoustics and, more recently, policy makers and practitioners show interest for soundscapes, due to its multidisciplinary approach focusing on how people actually experience their acoustic environments in different indoor and outdoor environments. In 2014 the International Organization for Standardization (ISO) officially defined Soundscape as “acoustic environment as perceived or experienced and/or understood by people, in context”. The peculiarity of the Soundscape approach is that it firstly relies upon human perception and then turns to physical assessment. The study of the soundscape related to cultural heritage is a subject not yet very widespread and deeply investigated by researchers and designers. In this paper, after an introduction about the general soundscape concept and approach, its connection with quiet areas is addressed. Moreover, existing methodologies to deal with the soundscape of cultural heritage are reported, together with the recent trend of archiving sounds considered to be disappeared or lost in memory, to enhance them as the cultural heritage of our society.

1. Introduction

Soundscape is defined as “acoustic environment as perceived or experienced and/or understood by people, in a specific context”. Soundscape represents a paradigm shift in the field of environmental acoustics: it combines physical, social and psychological approaches to the characterization, management and design of natural and urban sound environments [1]. Although the concept was introduced in the late Sixties [2,3], significant attention to it has mainly been paid, in the last two decades, in the field of community noise and environmental acoustics, by researchers, practitioners and policy makers [4,5]. To confirm this importance, the International Standard Organization in 2014 provided in ISO 12931 a definition and a conceptual picture of the soundscape, explaining the relevant factors for the measurement and reporting of studies and research concerning the soundscape, as well as for the planning, design and management of urban soundscapes, while also crucial gaps in soundscape research and open research issues for future advancements in the field have been identified, according to the explanatory diagram reported in figure 1.
Figure 1. The soundscape approach – source ISO 12931-1.

Specifically, in the ISO/DTS 12931-2 Technical Specification introduces techniques of interviews and guidelines, exploration of areas through soundwalks, but also the collaboration platform within a soundscape approach regarding urban design are introduced and discussed [6].

Soundscape research has also acquired considerable scientific relevance in recent years, going from just a few works published in international journals in 2000 to almost 400 publications in 2016 [7] and keeping the number of articles almost constant in the following years.

Recently, one of the most interesting areas of research and experimentation regarding soundscape is precisely that of cultural heritage.

In this frame, the UNESCO Convention for the safeguarding of the Intangible Cultural Heritage [8] has recognized the close connection between tangible and intangible cultural heritage and this concept has been enlarged. The archaeological areas have the peculiar feature to include both tangible and intangible cultural heritage to create a unique cultural identity which can be attractive for the tourists and important for the local and global community. These areas are also interesting because their acoustic environment, often formed by many sounds from tourists, outside recreational and commercial activities and surrounding road traffic, can greatly influence the tourists’ enjoyment of the area itself.

The way in which people interact with the soundscape of cultural heritage, as with the one of other identity places, is by means of perception. Regarding the perception of sound, Schubert stated that “identification of sound sources and the behavior of those sources is the primary task of the auditory system” [9]. Further studies have confirmed that categorization of everyday sounds operates mainly on the basis of source identification [10]. Ecological psychology recently drew attention to urban soundscapes, in which noise is emitted simultaneously by a wide variety of sources, to better understand how people sort out mixtures of sounds into discrete categories in their everyday lives [11]. Results converge to highlight a distinction between three categories, namely natural sounds, anthropic sounds and technological or mechanical sounds, the first two rising to positive reactions, whereas the last are associated to negative responses [12].

The aim of the current paper is to provide an overview about the most recently applied procedures to discover, analyze, protect and valorize the soundscape of urban cultural heritage, with reference to both sounds of tangible places and to the intangible sounds of memory.

2. The soundscape and its role in the acoustic society

The concept of soundscape is often associated to that of quiet area. A quiet area is defined by the Environmental Noise Directive (END) [13] in two scenarios:
- "quiet area in an agglomeration": 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;
- "quiet area in open country" shall mean an area, delimited by the competent authority, that is undisturbed by noise from traffic, industry or recreational activities.
Except for the formal definition provided above, the END does not provide a detailed methodology for dealing with quiet areas. In fact, after the first review phase of the END implementation, many Member States reported the absence of any guidelines about quiet areas. Five years later during the second implementation review of the END, it emerged that the majority of EU Member States had still not designated any quiet areas. The number of existing quiet areas had increased by 50% in the second END revision; however, this increase was accounted for by just five Member States (Austria, Hungary, Ireland, Lithuania and the UK - considering only Wales and Scotland). Moreover, the Countries or cities that had introduced criteria to deal with quiet areas had adopted very different approaches as stressed at European level [14, 15]. In the last years, especially thanks to some EU funded projects e.g. LIFE QUADMAP [16], more specific indications have been provided in order to deal with quiet areas and it emerged that in protecting quiet areas it is important to detect their specific acoustic features and correlate them with the reactions of people visiting the area. In this respect a multidimensional approach to the analysis of soundscape appears to be the most appropriate and wide accepted, as it takes account of its complexity and multidisciplinary [17].

In general terms, the soundscape approach is widely considered a valid instrument to be applied in the holistic design of urban and peri-urban places. In the implementation of the LIFE+2008 HUSH (Harmonization of Urban noise reduction Strategies for Homogeneous action plans, www.hush-project.eu) and of the LIFE+2010 QUADMAP (Quiet Areas Definition and Management in Action Plans, www.quadmap.eu) projects in Italy, some traditional strategies for soundscape analysis have been applied. In the frame of both projects [18, 19], some interventions of environmental noise reduction in courtyards and outdoor areas of primary schools have been developed according to the participatory design. In all these case studies the results of acoustic measurements in ante-operam scenarios had shown the need to protect school gardens and outdoor areas from traffic noise emitted by nearby road infrastructures.

This need has been confirmed by the non-acoustic investigation carried out with the soundscape analysis. In fact, the design of functional urban furniture and the introduction of elements facilitating citizens’ perception of well-being in urban living spaces represents a new frontier to explore. It includes, among its characterizing data, the definition, correction and qualification of the sounds that contribute to enjoy the environment and protect it from disturbing noises. The definition of the sound space, as a significant part of a wider landscape and functional context, is one of the basic elements of holistic design, vision and methodology that favors integrated, sustainable and environmentally friendly solutions. Hence the need for an innovative approach to noise control in urban environments which goes beyond mere compliance with the acoustic limits set by laws and regulations, which often overlook cultural and functional dimensions of the regulated spaces, also according to the indications provided by the World Health Organization (WHO) which recognize the environmental noise an important public health issue [20]. The consideration of the acoustic well-being perceived by those who live and animate urban living environments is an emerging approach, useful for the correct evaluation of the acoustic quality and for an improved design of the usability of squares, urban green areas and public spaces. Here the acoustic experimentation based on the soundscape analysis and on the aesthetic, holistic and serendipity parameters that characterize it and link it to the variables of global comfort, is producing truly remarkable results. In this context, also the definition of noise as “sound out of place”, attributed to W. Clarkson Kaye [21], takes on a meaning that can be read as an analytical and corrective element of the soundscape of an urban scenario, where any possible judgement of objective quality is subordinate to the evaluation of perceived quality linked to cultural factors and life experiences of people.

In urban planning, to design outdoor and indoor spaces, it is not possible to ignore the “immersive” perception of the landscape that represents the viewer’s perceived surroundings, that is, “the world around us” and not “in front of us” [22]. In this transition from an object of contemplation to a lived (or to be lived) space of life, perception is necessarily multisensory, and the sound component becomes an important element in the fruition of the landscape.
The modern soundscapes, especially the urban ones, are therefore defined as the perceived surroundings of every living creature, which also becomes common surroundings when shared cultural models are used. As a real autopoietic system, it redefines itself and, within itself, it supports, modifies and reproduces itself, thanks to the contribution, voluntary or involuntary, of those who live there, no longer as observers but as elements of the dynamic systems that we call urban soundscapes.

Researchers and designers dealing with soundscape frequently ask themselves questions such as “Which sounds, which sources are part of the soundscape of a given urban space and modify it, to the point of creating a variant, perceived in a different way from the original?”, “How are the sounds produced inside or outside the receiving urban environment, a space for listening and perception, propagated and modified?”, “How to catalogue urban sounds, harmonic and non-harmonic, and noises “out of place sounds”?” and, finally, “Which are the procedures adopted by experts to analyse the soundscape of cultural heritage?”

3. Soundscape of cultural heritage: methodologies for analysis

Over the recent years an increasing number of studies have been published on soundscape, proposing methods for its characterization, classification and practical approaches for its improvement [23]. In the work carried out by Brambilla et al. [24] the approach applied in the frame of the SONORUS project was aimed at characterizing the soundscape of “Foro Romano” which was deteriorated by noise present outside the area. In another work of Brambilla et al. [17] the aim was to study the soundscape of the archaeological area of Pompei, to be considered as a quiet area or, rather, “area of high acoustic quality”. The approach applied in the previous works consisted in three phases: measurement of the sonic environment, submission of questionnaires to visitors and data analysis.

During the first phase, acoustic data have been collected by a sound level meter and by binaural recordings. The binaural recording technique builds on the principle of placing microphones on a human’s head by headphones. The microphones’ position is either just outside each ear canal or at the bottom of the ear canal close to the eardrum. When you reproduce the recording and listen with headphones, the image is very much similar to “being there”. Moreover, for each pilot site, the acoustic and psychoacoustic parameters such as roughness and fluctuation strength were determined. The questionnaires’ submission has been carried out simultaneously with the acoustic measurements and information such as motivation to stay in the area, perceived quality of security, maintenance, cleanliness, environment, soundscape, landscape and smell, sounds expected to hear, sounds actually heard and those making the area pleasant, soundscape attributes, predominant nature of soundscape, visual elements, landscape attributes have been collected.

Regarding data analysis, techniques of multicollinearity analysis between the variables applying the Spearman’s rank correlation coefficient r and cluster analysis have been adopted.

4. The archive of lost sounds

Since 1995, the Center for Hearing and Communication has been promoting the Noise Awareness Day internationally. Since 2010, the Italian Acoustics Association has organized the INAD-Italy Awareness Day, with the aim of increasing awareness of the dangers of long-term exposure to noise and counteracting its effects both on hearing and, more generally, on health. The INAD-Italy working group coordinates the activities in the Italian schools participating in the initiative, organizes a competition for prizes for the production of graphic and audio/video materials on specific topics of acoustics, distributes information materials, organizes workshops, lectures and educational moments of awareness held by experts in acoustics, promotes advertising campaigns against noise and prevention of hearing damage. The 2019 edition of INAD Italia, entitled "In search of lost sounds", focused on the theme of researching and listening to sounds that have been forgotten or are destined to disappear with environmental, social and occupational changes, thus promoting awareness of the richness of the acoustic environment in which we live [25].

Moreover, During the INAD 2019 edition, a website (http://www.eracustica.eu/) was also set up to collect indications, through simple questionnaires, of the sounds or noises that remain in people's
memories, even if they have disappeared or are destined to be forgotten. The questionnaire is open to all and has allowed to collect data from a mixed sample of population. In fact, it is made up of a personal part followed by the request for the insertion of a maximum of three sounds or noises that belong to the memory of the interviewee [26]. At the end of September 2019, about 350 people answered the questionnaire and about 1000 lost sounds have been indicated, as illustrated in figure 2.

![The five most remembered sounds](image)

**Figure 2.** The most frequent “lost sounds” - [http://www.eracustica.eu/](http://www.eracustica.eu/).

Recently, in fact, the same sounds, which have become rare, at risk of disappearance or common, have become part of that cultural heritage to be enhanced and/or protected and are collected on magnetic tape or digital support, also as online maps of immediate use. A concrete example is represented by the possibility that such archiving can offer to study all the changes in the places lived in our cities, also thanks to listening to the precious audio material collected over the years [27].

5. Sound and identity of places

In both urban and rural areas, as well as in uninhabited lands, sounds are a part of the identity of places. Studying them from a historical, naturalistic and social point of view could help to safeguard and enhance them. Moreover sound is an essential part of communication between humans, in the form of speech and listening, warning, music and creative sounds. The enhancement of depressed, abandoned or unattractive areas sound is an important challenge for urban planners. The use of tailored sound enrichments can change the perception of places, making them more pleasant, comfortable, interesting, safe. The sound enrichment solutions have proved to be more effective when the sounds designed were somehow connected to the identity of the places.

In the recent years some projects have been developed in Tuscany aiming to give evidence to the sound identity of urban places, also considering experiments of sound enrichment with natural or composed soundscape elements. Recorded biophonies and/or geophonies harmonized with music, voices, and even technophonies have been proposed as elements of sound design in urban areas. In 2018 the project “Urban sound and soundscapes” was developed in Pistoia [28]. Guided soundwalks were organized for citizens, to check their reactions in twelve selected points (squares, markets, churches, public buildings, corners, ...) of the city centre where the urban soundscapes had been modified adding sound elements that underlined the identity of each place. A group of acousticians and urban designers made the city resonate with the help of physical, acoustic musicians, able to excite not only with their own instruments but also the urban soundscape of the selected places. Presences and actions were orchestrated in highly meta-compositional scenarios to support soundwalk exploration. Musicians acted as prototypical inhabitants of the urban spaces, capable of inspiring new and extraordinary models of urban relationship, contributed to reveal the historical and cultural identity of the city centre of Pistoia. Soundscape experts collected suggestions from the experience of listening modified soundscapes, in the methodological perspective of offering a wider expressive endowment to
the designers of the city of the future. Another similar project is planned for September 2020 as part of the Italian initiatives for the International Year of Sound: the “Historical and natural soundscapes” project in the Regional Park of Maremma.

The event is divided into a series of initiatives regarding immersive knowledge experiences in the Maremma Park, exploring the natural soundscape, the relationship between geophones, biophonies and anthropophonies, and of course the sound identity of the place, including those that are destined to disappear with environmental and social changes. The soundwalks in the park are conceived to involve the participants in the exploration of the historical and natural soundscapes.

The historical soundwalk in the park is dedicated to the time of Etruscan civilization: it includes installations and performances of sound enrichment related to the theme of the culture and music of the Etruscan, in collaboration with the Archaeological Civic Museum of Vetulonia, some original soundscapes will be reconstructed, ancient musical instruments will be played in the same natural scenarios where their sounds had been heard during the pre-Roman era.

The natural soundwalk in the park includes listening to natural sounds and sound enrichment experiments starting from the Park's biophonies and geophonies, typical of the autumn season. The recording of the sounds of the place is also carried out before, during and after the walk, in order to understand how the human presence impacts the characteristic soundscape of the environment.

The soundwalks take place on paths comprising several listening points where it is possible to concentrate on the perception of sounds. Each sound event is configured as a moment of cultural enrichment and critical contemplation of the sound landscape and as a collection of sounds and images through acquisition systems of visual and sound fragments.

6. Conclusions

Soundscape is defined as “acoustic environment as perceived or experienced and/or understood by people, in context”. Different research approaches are currently applied in this field depending on the object of study (e.g., individual sensory experience, group behaviour, acoustic properties, or invested meaning). The diversity of the existing research methods suggests that soundscape, both as an object of study and as a field of research, is still under development [29]. A standard approach applied in the evaluation of the soundscape of cultural heritage consists in three phases: acoustics measurements, questionnaire submission to users, data analysis. In this frame, according to the authors, an aspect that could further explored in the future goes beyond the analysis of the soundscape of cultural heritage and it is related to the appropriate design of indoor and outdoor places also in order to ensure good and satisfactory usability even from an acoustic point of view. Some designing experiences have been carried out in this sense by authors with the “Urban sound and soundscapes” project in Pistoia and are supposed to be replicated, although with different approaches adapted to the context, in “Historical and natural soundscapes” project in the Regional Park of Maremma

Moreover, another very current trend is that of archiving, in the form of audio files or sound maps, those sounds considered peculiar or at risk of disappearance, believing that also sounds have an important role in the valorisation of cultural heritage and in the maintenance of its identity.

References

[1] Kang, J., Aletta, F, The impact and Outreach of Soundscape Research, Environments 2018, 5(5), 58.
[2] Southworth, Michael (1969), "The Sonic Environment of Cities". Environment and Behavior. 1 (1): 49–70. doi:10.1177/001391656900100104. hdl:1721.1/102214.
[3] Schafer, R. Murray (1977), The Soundscape: Our Sonic Environment and the Tuning of the World. Alfred Knopf.
[4] Kang, J., Aletta, F., Gjestland, T.T., Brown, L.A., Botteldooren, D., Schulte-Fortkamp, B., Lercher, P., Van Kamp, I., Genuit, K.; Fiebig, A.; et al., Ten questions on the soundscapes of the built environment. Build. Environ. 2016, 108, 284–294.
[5] Kang, J., From dBA to soundscape indices: Managing our sound environment. Front. Eng.
Manag. 2017, 4, 184–192.
[6] Schulte-Fortkamp, B., Soundscape, Standardization, and Application, Euronoise Congress, 27-31 May 2018, Crete (Greece).
[7] Scopus database
[8] UNESCO, Convention for the Safeguarding of Intangible Cultural Heritage, Paris, 2003.
[9] Schubert, E.D. (1975), The role of auditory perception in language processing. In D.D. Duane & M.B. Rawson (Eds.), Reading, perception, and language, (pp. 97-130). Baltimore, MD, York Press.
[10] Gaver, W.W. (1993), What in the world do we hear? An ecological approach to auditory event perception. Ecological Psychology, 5(1), 1-29.
[11] Maffiolo, V., David, S., Dubois, D., Vogel, C., Castellengo, M., Polack, J.-D. (1997), Sound characterization of urban environment, Proceedings Internoise 97, Budapest, Hungary, 25-27 August 1997.
[12] Guastavino, C. (2006), The ideal urban soundscape: Investigating the sound quality of French cities. Acta Acustica united with Acustica, 92(6), 945-951.
[13] Directive 2002/49/EC of the European parliament and of the council of 25 June 2002 relating to the assessment and management of environmental noise.
[14] European Environment Agency. Good practice guide on quiet areas. Technical Report 4/2014, 903 2017.
[15] LIFE+HUSH project. Life+2008 HUSH (Harmonization of Urban noise reduction Strategies for Homogeneous action plans) guideline for a harmonized urban noise action planning. Technical report, 2013.
[16] Bartalucci, C. et al., LIFE+2010 QUADMAP Project: results obtained from the analysis of data collected during the application of each phase of the developed methodology, Noise Mapping Journal, 6(1), 2019.
[17] Brambilla, G., De Gregorio, L., Maffei, L., Masullo, M., Soundscape in the archaeological area of Pompei, ICA Congress, 2-7 September 2007.
[18] Borchi, F., et al., “LIFE+2008 HUSH project results: a new methodology and a new platform for implementing an integrated and harmonized noise Action Plan and proposals for updating Italian legislation and Environmental Noise Directive”, Noise Mapping Journal, 3, 71-85 (2016).
[19] I. Aspuru I. et al., “LIFE+2010 QUADMAP Project: a new methodology to select, analyze and manage Quiet Urban Areas defined by the European Directive 2002/49/EC”, Noise Mapping Journal, 3, 120-129 (2016).
[20] World Health Organization, Environmental Noise Guidelines for the European Region, 2018.
[21] Kaye, G. W. C., The Measurement of Noise, Proceedings of the Royal Institution of Great Britain, 26, 435-488, 1931.
[22] Luzzi, S., Holistic approaches in urban planning and in the acoustic design of buildings, Proceedings of the 48th Congreso Espanol de Acustica – European Symposium on sustainable building acoustics, 2017.
[23] COST TUD Action TD-0804 (2013) http://soundscapecost.org/documents/COST_TD0804_Ebook_2013.pdf.
[24] Brambilla, G., Maffei, L., et al., The Perceived Quality of Soundscape in the Archaeological Area of “Foro Romano” in Rome, Journal of temporal design in architecture and the environment, ISSN 1346-7824, 2018.
[25] Luzzi, S., Natale, R., Delle Macchie, S., Bartalucci, C., The “Sound of my place” experience in the frame of the International Noise Awareness Day, Internoise Congress, 12-16 June 2019.
[26] Di Feo, G., Cerniglia, A., Magrini, A., Quaranta, C., TRACCE DEL TEMPO: I SUONI DELLA MEMORIA, Neo-Eubios 69, settembre 2019.
[27] https://napolisoundscape.com/
[28] Luzzi, S., Bartalucci C., et al., Participative soundscape projects in Italian contexts, Internoise Congress, 12-16 June 2019.
[29] Östen Axelsson, O., Guastavino, C., Payne, S.R., Editorial: Soundscape Assessment, Front.
Psychol. 10:2514, 2019, 10.3389/fpsyg.2019.02514.