Preserving and managing the sonic heritage of the performative spaces of the past

Angela Bellia

Istituto di Scienze del Patrimonio Culturale,
Consiglio Nazionale delle Ricerche,
Via Cardinale Guglielmo Sanfelice, 8,
80134 Napoli
angela.bellia@cnr.it

Ricevuto: 8/11/2022
Accettato: 22/1/2023

DOI: 10.3280/ria1-2023oa14845
ISSN: 0393-1110
ISSNe: 2385-2615

The ongoing "Sonic Heritage" project aims to develop a new multidisciplinary analytical approach that models the relationship between the intangible aspects and the spatial configuration of performative spaces of the past in order to assess the sound pollution risks to cultural heritage of particular case studies in Italy, and to contribute to the monitoring of present-day sound and noise for the future management and preservation of historical cultural heritage.
Moreover, this project also concerns the risk assessment of sonic heritage in ancient theatrical spaces as well as the modern reuse of these theatrical structures and the relationship with their intangible aspects, environment, and landscape. This paper will present some issues raised by the "Sonic Heritage" project concerning the study of sonic heritage of ancient theatres and how sonic heritage could be preserved and managed in the future.
Keywords: sonic heritage, modern reuse of ancient theatres, historical acoustics

Conservazione e gestione del patrimonio sonoro degli spazi performativi del passato
Il progetto in corso "Sonic Heritage" mira a sviluppare un nuovo approccio analitico multidisciplinare che modelli la relazione tra gli aspetti intangibili e la configurazione spaziale degli spazi performativi del passato al fine di valutare il rischio dell'inquinamento acustico del patrimonio culturale di casi studio in Italia e di contribuire al monitoraggio dei suoni e dei rumori in questi spazi per la loro futura gestione e la tutela del patrimonio storico culturale.
Inoltre, questo progetto riguarda anche la valutazione del rischio del patrimonio sonoro negli spazi teatrali antichi, nonché il loro riutilizzo moderno e il rapporto sia con i loro aspetti immateriali sia con l'ambiente e il paesaggio. Questo contributo presenta alcune questioni sollevate dal progetto "Sonic Heritage" che riguardano lo studio del patrimonio sonoro dei teatri antichi e come questo possa essere preservato e gestito in futuro.
Parole chiave: patrimonio sonoro, riuso moderno dei teatri antichi, acustica storica

1 | Introduction

Ancient theatres are spread across a large territory that covers three continents (Africa, Asia, and Europe). Their presence bears witness to belonging to common roots, contributing to promote mutual understanding and intercultural dialogue. Their preservation and their continued use as spaces for cultural activities allow us to promote the encounter between the cultures, recovering the memory and awareness of a shared history through the arts and architecture [1]. The international community has urged the commitment to preserve ancient theatres from the ravages of time and the action of human beings: given that disastrous natural events, pollution and/or improper uses of these buildings and their related performative spaces are progressively damaging this cultural heritage, effective preservation planning policy based on the prevention and mitigation of vulnerabilities and dangers is vital. Despite its relevance to this field, no previous study has focused on the risk assessment of acoustic features as sonic heritage of ancient theatres and the related performative spaces, some of which are now used as locations for concerts and modern performances.

The analysis of the acoustics characteristics of ancient theatres as sonic heritage of performative spaces devoted to communication and social interaction can reveal hidden aspects on how sound influenced people and what this meant for humans as individuals and social beings in the past. Regarding the research on sound as heritage, a preliminary remark is necessary, given that, especially in the ancient performative spaces of the past, the sonic features of these spaces played a fundamental role in improving the sonic experience related to musical and dancing performances, as well as that of theatrical plays performed in these ancient places. However, as something that does not tend to leave direct material traces, sound is not often considered in the archaeological field [2]. In the case of the performative spaces and architectural structures, the relationship between sound

and space is a fundamental aspect of understanding how sound and listening contributed to the appreciation of the properties and dimensions of the spaces, as well as to auditory culture in antiquity more generally.

This relationship can be investigated using a new approach in the study of material evidence in line with recent developments in archaeology over the past few decades. It is of particular relevance to new approaches focused on the understanding of how ancient people experienced their built and natural environment [3].

Given that sound has always been an omnipresent component of human experience, recent trends in archaeological inquiry have taken into consideration the importance of acoustics and what was heard in the past, analysing whether it is possible to ascribe cultural meanings to the sonic features of ancient spaces, and whether ancient architecture reacted to performance developments as well as to musical, vocal and dance practices by modifying or by designing new buildings and spaces for performances. Moreover, current research approaches to archaeoacoustics, soundscapes, and archaeomusicology have highlighted how new sonic hypotheses could be explored, especially thanks to the use of technology in these research fields, by using, e.g., 3D software model of the architectural structures and the SPreAD-GIS (System for the Prediction of Acoustic Detectability) [4]. In this regard, the study of sonic heritage through digital technology and virtual acoustic analysis is revealing how the commitment of researchers is proving to be invaluable in overcoming disciplinary barriers and fostering the inclusion of research on sonic heritage in the archaeological field and in the Humanities in general.

It is worth noting that physical and humanistic approaches consider the concept of "space" differently. In acoustics, a space is considered for the acoustic characteristics related to the physical sound properties in a place. In soundscapes, space physicality creates an understandable and evaluable environment in combination with sounds. For this reason, the space includes not only the place's physicality but also social and public events as well as performances, creating the context of human experiences. Therefore, since the concept of space is entangled with sonic heritage, and all aspects of life in antiquity in general, it cannot merely be studied through quantitative methods. Comparing the subjects and methods from acoustic space to auditory space indicates a shift from quantity (in acoustics) to quality (in the soundscape) and from quality to wholeness of the "sonic fabric" (in auditory space): it demonstrates how the study model of these approaches is based on the pivotal concepts of human interaction and behaviour, sound, environment, and place [5]. This relationship provides results that are relevant to the study of sonic heritage. In this respect, exploring the properties of sound in performative contexts allows us to gain new insights into the social utility of ancient spaces and to explore the connection between acoustic and auditory space as an intangible consequence of the space's tangible construction.

2 | The Sonic Heritage Project

The project "Sonic Heritage. Risk Assessment and Sustainable Development of Acoustic Environments of Ancient Theatres" which is being carried out at the Institute of Heritage Science, National Research Council of Italy, aims to develop a new multidisciplinary analytical approach that models the relationship between the intangible aspects and the spatial configuration of ancient theatrical structures in order to contribute to the monitoring of present-day sound and noise for their future protection and preservation and their modern reuse. Despite significant past and current work on the acoustics of ancient theatres, no project up until now has approached these issues with a systematic and interdisciplinary effort. For the first time, all the results have been integrated into an innovative research method from which experimental 3D reconstructions integrating acoustic models can be created. As such, this research presents a sustainable model for future integrative scientific studies in the fields of digital heritage and sonic heritage in theatrical spaces, and provides a new approach to reconstruct sound phenomena and auditory experience in ancient performative spaces [6], enhancing our understanding of the role that sound played in all aspects of society in the past.

Moreover, this project aims to explore the risk assessments of sonic heritage in theatrical spaces of particular case studies in Italy (the theatres of Syracuse and Segesta) and the relationship with their intangible aspects. When taking this understanding of sound into account, it seems surprising that important public spaces in antiquity, such as ancient theatres, have been investigated in the archaeological field almost exclusively with a focus on their visual function as performative spaces in which individuals or groups display and experience their collective or personal identities and status. Approaches such as these often fail to take into account the full range of sonic experiences that the performative spaces may have provided [7]. However, this was an important aspect of ancient life that can be investigated using a new approach to archaeological remains [8].

3 | Sonic Heritage of Ancient Theatres

By preserving ancient theatres as an important part of cultural heritage, it is possible to hand down not only the developments of theatrical architecture in the ancient world, but also to interpret the signs that different cultures have brought to the original model. Investigations into the geometric design and sonic dimension of these structures may help us to the knowledge of the wide variety of uses and functions that sound fulfilled in ancient buildings; it can also enhance our understanding of the links between the form and sonic function of ancient theatres, and their transformation from generic or conventional built structures to buildings that can amplify the active sound properties of architecture.

The sonic dimension of theatrical structures involves these performative spaces as places for interaction and communication in the natural and human sonic environment. Indeed, architectural structures, decoration, and surrounding landscapes created specific sonic features which influenced the soundscape of theatrical structures; these soundscapes consisted not only of music and recitations, but also natural elements, such as geophony and biophony [9]. The survey on these elements is useful to evaluate how sound in a landscape is a fundamental aspect of the complex relationship between spaces, social interactions, and the natural environment, as well as to assess how soundscape refers to human-environmental interactions and consists of all sounds present in any given environment, and how these sounds interact within that environment. This investigation provides critical information about sound in archaeological contexts and how sound is a valuable means of becoming better informed on the many different ways in which sound pervades spaces, architectural places, social interactions, and also human relationships.

By designing and constructing new theatrical shapes, architecture answered to the evolution of music and musical instrument developments as well as to vocal practices in the past [10]: sonic features of a particular space might have directed the choice of suitable places in order to gain a greater understanding of the sounds produced in that space. On the other hand, the development of architecture and the evolution of the form of theatrical spaces seem related to the presence of an ever-increasing number of participants in performances and assemblies, where performers and speakers needed to be clearly understood by the audience. In this regard, it is necessary to consider how the preservation of the acoustics of ancient theatres as well as the deeper knowledge of their original sonic features could be fundamental not only for the revival of ancient tragedies and comedies, but also to arrange appropriate musical and dance activities and modern performances in theatrical locations. Moreover, it is crucial to identify the risk factors related to their acoustics in order to minimise damage should they occur, thereby managing their future protection.

4 | The cases of Syracuse and Segesta

In this context, the theatres of Syracuse (5th c. BCE) (Figure 1) and Segesta (3rd c. BCE) (Figure 2) play a pivotal role given that modern concerts and festivals performed in these spaces pose a high risk for the buildings' sonic heritage. In this regard, it is worth mentioning the valuable work carried out by the research group at the Department of Energy, Politecnico of Torino, on the contemporary use of ancient theatres [11]. Their study was focused on the theatre in Syracuse as an archaeological site, with a particular focus on sustainable solutions for passive acoustics.

The survey of preservation best practices of these extraordinary monuments in Syracuse and in Segesta led institutions to host two important meetings on the safeguarding of ancient theatres in the Mediterranean area. These two

Fig. 1 – The theatre of Syracuse (5th c. BCE)

Fig. 2 – The theatre of Segesta (3rd c. BCE)

conferences were aimed at the application of the "Convention for the Protection of European Architectural Heritage" (Granada, 1985) and of the "European Convention for the Protection of Archaeological Heritage" (Malta, 1992). The results of the first meeting (Segesta, Trapani, Palermo, 17-20 September, 1995) were formulated in the "Declaration of Segesta" (1995), where there is a generic reference to acoustic issues and the need to limit acoustic emissions "in order to avoid harmful vibrations to the monuments and to respect the peace of the local people" [12].

The second meeting, "Ancient Theatres in the Mediterranean Area", took place in Syracuse (13-17 October, 2004). One of this conference's stated goals was the approval of the Charter of Syracuse [13]. This is a political declaration reiterating the international community's commitment to the preservation and enhancement of cultural heritage and ancient theatres. Since the Declaration of Segesta (1995), many steps have been taken to develop a strategy that can allow us to enjoy these theatres in the future and allay the risks associated with their use. The Charter of Syracuse for the preservation, fruition, and management of ancient theatrical architectures in the Mediterranean was undoubtedly a major step forward, especially because it moved beyond the usual statements of principles. It has proved to be truly valuable, including operationally, in specific activities implemented by those involved in the management of ancient theatres. However, within this Charter, only a short paragraph is devoted to the preservation of the acoustic features of ancient theatres. Moreover, no

technical guidance has been provided, nor are there detailed references to the sonic characteristics of ancient theatres as heritage that is worth safeguarding and protecting.

It is worth remembering how recently we have witnessed a heated debate on the dangerous acoustic effects of the events in the theatre of Syracuse, where pop singers and rock musicians performed concerts during the Summer of 2022 [14]. The type of these concerts inevitably invited the audience to dance and to move in a lively manner in the fragile architectural structure of the theatre carved into the rock (Figure 3). Nobody can foresee the consequences of these performances. The lack of clear rules and acoustic parameters could be very dangerous for the future of this exceptional monument. Improper music and acoustics in this theatre, human behaviour during concerts, and unsuitable performance-induced hazards are persistently putting its sonic features under pressure, with an incremental annual frequency.

Fig. 3 – The theatrical architectural structure carved into the rock in Syracuse

Research devoted to risk assessments, sustainable solutions for mitigation, and adaptation strategies specifically dedicated to the building's sonic heritage protection are urgently needed for this theatre. When musical events are planned at this monument, the guidelines of the Charter should always be kept in mind, which allow the use of ancient theatres only if precise criteria are respected, starting with the current condition of each part of the theatrical structure: *cavea*, *orchestra*, stage buildings, and especially acoustics. The use of ancient monuments inevitably wears them out and can erase data useful for accurate historical and archaeological research as well as exploration of their sonic heritage. The use of theatres that have not been studied and adequately documented, or that are known to be vulnerable from the acoustic point of view, should not be used as locations for unsuitable performances. Moreover, a more appropriate choice by responsible institutions of musical repertories and performance set-ups could guarantee respect and preservation for the management of the sonic heritage and acoustic features of ancient theatres in the future.

5 | Sound as heritage

Given the evocative potential of the original spatial configuration, the acoustics of ancient theatres is a valuable cultural asset which must be protected. The study of the sonic environment of these structures could provide us with new insights on how audiences interacted with soundscapes and landscapes. This is a novel way of approaching and analysing archaeological sites in order to speculate on the soundscape of performative spaces in the past as well as to explore how they were experienced. In this regard, the "Sonic Heritage" project is developing a new approach to the knowledge of the acoustic design of theatre buildings obtained through 3D virtual reconstructions and the creation of acoustic models, taking into consideration the philological reading of the original system and the theoretical verification of available data. Performing analysis on the best sound effects in ancient theatres will help significantly in establishing more precisely the sound-in-space nexus in performative spaces, combining their acoustic model with a new method for generating 3D models and for exploring the sonic properties of any performative space in the future.

It is worth noting that the application of new technologies to cultural heritage research has led to important methodological changes in the protection and enhancement of monuments. This new approach is stated in the objectives of the "International Council on Monuments and Sites" [15], an organisation which aims to restore meaning and preserve the memory of historic buildings, promoting the application of technology in the assessment of monuments: this is particularly interesting with regard to the recovery of evidence of sonic aspects in archaeological heritage [16]. Within this context, new methods for the analysis of historical sonic heritage of ancient theatres should be used, enabling the evaluation of their sound quality by using auralisation techniques [17] that allow cognitive and physical elements to be reproduced and combined. By using three-dimensional (3D) methods for ancient theatres mapping, these methods can be used to document all evidence, with particular attention given to the spaces used for social events. Moreover, topographic data can be processed using ArcGIS software for analysing the spatial relations of the architectural structures [18]; the systematic study of these basic elements, which are regularly a part of archaeological reporting, can be used in order to form the foundation for acoustic analysis. Collecting 3D coordinates on all material and managing this data with GIS software can provide a means for reconstructing the measurements and the original spatial and sonic, and environmental relationships that existed in these spaces [19]. These reconstructions are critical for answering questions about the processes of aural analysis.

Moreover, by combining the detection of acoustic emissions with computer processing, the acoustic impact of electronic sound amplification instruments on the theatrical buildings and the sonic stresses of these instruments on these ancient buildings [20-21] should be assessed with

close attention. In this regard, the acoustic parameters of the sustainability of modern performative activities in ancient theatres should be defined through specific acoustic analysis. In addition, the critical issues of theatrical buildings [22] should also be identified by evaluating the data of vibrations produced by acoustic sources in relation to different types of performances [23].

6 | Conclusions

The "Sonic Heritage" project will provide a new path of investigation in terms of the digital preservation of acoustic models of historical spaces and their sonic heritage. It will be, therefore, possible to critically explore the links between the propagation of sound and the shape evolution of the theatres as well as the role of the architectural elements' configuration in featuring the sonic characteristics of these ancient buildings [24-25]; these data will provide suitable suggestions to optimise the acoustic performance of theatre architecture, or to define the most suitable solutions for modern performances. Moreover, acoustical measurements and models of ancient theatres offer a robust additional layer to their preservation, especially for locations that are at-risk, thereby managing their future protection and their modern reuse.

In summary, a rediscovery of the influence of sound on ancient theatres could help to increase the wellbeing of modern societies and protect the environment from noise pollution of human origin. The results of the "Sonic Heritage" project can have the potential to better understand the current sonic environment and ecosystem and their meaning to human beings, as well as the physiological responses to a sound environment in the present as well as in the past.

Conclusioni

Il progetto "Sonic Heritage" fornirà un nuovo percorso di indagine in termini di conservazione digitale dei modelli acustici degli spazi storici e del loro patrimonio sonoro. Sarà, quindi, possibile esplorare criticamente i legami tra la propagazione del suono e l'evoluzione della forma dei teatri nonché il ruolo della configurazione degli elementi architettonici nel 'dare forma' alle caratteristiche sonore di questi antichi edifici [24-25]; questi dati potranno fornire opportuni suggerimenti per ottimizzare le prestazioni acustiche dell'architettura teatrale, o per definire le soluzioni più idonee per gli spettacoli. Inoltre, le misurazioni e i modelli acustici dei teatri antichi offrono ulteriori elementi per la loro tutela, soprattutto per quelli che sono a rischio, gestendo così la loro futura protezione e riutilizzo.

In conclusione, una riscoperta dell'influenza del suono dei teatri antichi può contribuire ad aumentare la consapevolezza sul ruolo svolto dal suono sul benessere sociale e a sollecitare la protezione dell'ambiente dall'inquinamento acustico prodotto dagli esseri umani. I risultati del progetto "Sonic Heritage" hanno il potenziale per favorire la comprensione dell'ambiente sonoro e dell'ecosistema, nonché delle risposte fisiologiche all'ambiente sonoro del presente come del passato.

Acknowledgements

The "Sonic Heritage" project is inspired by the author's previous research, namely "Stesichoros. The Archaeology of Sound in a Greek City in Sicily" (792058). This project was funded by the European Commission's Marie Skłodowska-Curie Actions Programme, Individual Fellowships.

This contribution is an extension of the previously published conference paper in the PROCEEDINGS of the 2nd Symposium: The Acoustics of Ancient Theatres, which took place on 6-8 July 2022 in Verona, Italy.

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