

Proceedings
7th Conference on Acoustic Ecology
Athens, Ancient Epidaurus
Soundscapes, Biophony and Climate Crisis

7-10/11/2024



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Hellenic Society for Acoustic Ecology

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7th Conference on Acoustic Ecology
"Soundscapes, Biophony and Climate Change Crisis"

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Proceedings

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Preface

Sound offers a sensitive means of registering change. The erosion of ecosystems, the loss of biodiversity, and the impact of extractive urban processes are often first perceived acoustically before they are rendered visible or measurable. Within this context, acoustic ecology operates as an interdisciplinary field of research and practice as well as a form of ecological care. It relies on attentive listening as a means of acknowledging harm, sustaining memory, and cultivating more than just reparative relationships between humans and the more-than-human world.

The 7th Conference on Acoustic Ecology, *Soundscapes, Biophony and the Climate Crisis*, took place in Greece (7-10/11/2024) in Athens and Ancient Epidauros, organized by the Department of Music Studies of the NKUA in collaboration with the Hellenic Society for Acoustic Ecology and the Municipality of Epidauros. The 7th Conference on Acoustic Ecology convened at a moment of profound ecological, cultural, and ethical urgency. As accelerating environmental change reshapes the acoustic character of the planet, listening becomes both a method of inquiry and a form of responsibility. The 7th Conference on Acoustic Ecology brought together researchers, artists, practitioners, and scholars from around the world to explore the evolving relationships between sound, environment, culture, and society. Situated in Athens, a city where history, urban life, and sonic heritage intersect, the conference provided a resonant setting for critical reflection on how sound shapes and is shaped by ecological, technological, and social conditions.

The most notable moments of the conference were the two soundwalks at the Ancient Theatre of Epidauros and the Small Theatre of Epidauros. These walks were conceived not merely as experiential activities, but as ritual practices of attunement and care. In antiquity, the Theatre of Epidauros formed part of a broader healing landscape associated with the Sanctuary of Asklepios, where medicine, ritual, architecture, and performance were intertwined. Sound, voice, and communal listening were integral to processes of *θεραπεία*—understood not only as cure, but as ongoing care and balance.

Extending this embodied approach, the soundwalk at the ancient Theater of Epidauros situated listening within a site of exceptional acoustic and historical significance. Walking and listening together in this landscape—where architecture, nature, and voice have converged for millennia—participants were encouraged to attune to the continuity and vulnerability of sound across time, and to reflect on how ancient practices of listening may inform contemporary responses to the climate crisis.

Across keynote lectures, paper sessions, workshops, and artistic presentations, participants engaged with sound as an ecological, cultural, technological, and political phenomenon, framing soundscapes as both objects of study and tools for knowledge production, artistic practice, and environmental action. Contributions addressed soundscapes in virtual and augmented reality through geolocated audio, interactive installations, and data sonification that expand multisensory perception and awareness of planetary processes, while others foregrounded improvisation, embodiment, voice, and collective listening as ways of rethinking spatial experience and soundscape aesthetics. A substantial body of work advanced soundscape analysis through innovative qualitative and quantitative methodologies applied to urban, architectural, touristic, subterranean, and protected natural environments, alongside practices of documentation and digital preservation that highlighted acoustic heritage, traditional crafts, community memory, and the impacts of tourism and modernization. Further studies linked acoustic ecology with soundscape ecology, bioacoustics, and climate research, exploring biodiversity, geophony, human well-being, and ecological activism through listening practices and sonification. The diversity of perspectives represented in these proceedings reflects the interdisciplinary nature of acoustic ecology and underscores the field’s capacity to bridge scientific inquiry, artistic practice, and social engagement.

The contributions collected in these proceedings reflect the diversity of the Hellenic Acoustic Ecology society scientific research, soundscape studies, artistic inquiry, and community-based practice. Together, they articulate listening as a mode of knowledge production and as a practice of responsibility—one that can support environmental awareness, activism, and healing in times of crisis. Many of the works engage directly with threatened soundscapes, while others propose methods through which sound may function as a medium for restoration, stewardship, and collective resilience.

This volume brings together selected contributions originating from abstracts evaluated and accepted by the Scientific Committee, reflecting the thematic scope and research directions of the 7th Conference on Acoustic Ecology. The following topics are presented below in order to illustrate the breadth of the Conference themes and to highlight the diverse approaches represented in the selected contributions. Each thematic section offers a concise introduction to the papers it comprises.

Soundscapes in Virtual and Augmented Reality

In "Integrating Soundscapes with Augmented Reality: Design and Implementation of a Geo-Located Audio AR App on the European Trail E4 on the Sitia Plateau" Konstantina Stavropoulou and Magdalini Chatzaki explain the production of geolocated audio in AR application that reflects the historical and environmental narratives of the area in order to enhance users' multisensory environmental perception. In "Interactive electroacoustic music - the concert space as an ecosystem: The Mon Repos Augmented Soundscape Project - A site specific sound installation in a dialectic with its environment", Philippos Theocharidis presents an interactive platform for site-specific electroacoustic installations, integrating human, biological, geological, and artificial sounds into holistic soundscape ecosystems. In the paper "Exploring the Impact of Magnetic Storms on Earth's Ecosystem through Data Sonification" Christina Georgiou, Areti Andreopoulou and Anastasia Georgaki explore how innovative sonification tools can raise awareness of cosmic phenomena affecting the Earth.

Improvisation, body, voice and space and Acoustic Ecology

In "Listening Together Across Distances" Shortwave Collective research situated radio listening through a collective feminist practice. In "All That Is Solid Decays into Air - resonant gestures for ambiances creation", Nicolas Remy, Evangelia Paxinou and Petros Flampouris explore sonic encounters at Pilio Sanatorium, using improvisation and radio to rethink soundscape aesthetics and deepen environmental perception.

Soundscape Analysis

In "Echoes of Embodied Experiences: Walking Methodologies for Sensorial Research" Mersida Ndrevataj and Petros Flampouris demonstrate how the sensory methodologies of shadowing and sound recording uncover non visual dimensions of urban experience. Petros Flampouris and Nicolas Remy in "Non-standard acoustic measurement for architecture soundscape mapping" introduce qualitative and quantitative soundscape analysis tools to enrich architectural and planning design. In "The sound territories of diversity, between humans and non-humans. An anthropological-biodiversity approach of the soundscapes territorialization in urban resourcing areas", Philippe Woloszyn, Kahina Ikni and Elsa Alfonsi present a soundscape indicator for Bordeaux quiet areas, analysing human and non-human sound practices within urban ecological restoration projects. In "Soundscape of Agia Paraskevi Cave (Skoteino, Crete, Greece)" Maria Kantzaridou, Ioannis Ekklesiarchos, Panagiotis Georgiakakis, Ioannis Nikoloudakis and Kaloust Paragamian introduce innovative cave soundscape analysis, including ultrasounds, to monitor biodiversity, geophysical processes, and human presence in karst ecosystems. In "Measuring the noise footprint of tourism" Aggelos Tsaligopoulos, Stella Sofia Kyvelou, Nicos Bobolos, Aimilia Karapostoli and Yiannis Matsinos develop a noise footprint calculator for Lesbos tourist accommodations, assessing soundscapes and seasonal variations to promote sustainable acoustic management.

Soundscape analysis and Digital Preservation

Natalia Lithadioti and Theofanis Maragkos in "The Sound of the Last Traditional Tinsmith of Skopelos" present the sonic methods for producing a sound documentary about the craft of tinsmithing and its socio-cultural environment. In "Soundwalks at Protected Areas, The case study of the National Marine Park of Zakynthos" Foivos Adamidis, Kalliopi Chatzimichail, Sofia Kapota, Panagiotis Karounias, Maria Makri, Theofanis Maragkos, Charikleia Minotou and Christos Paleologos use Acoustic Ecology practices to create communicative materials for Protected Areas and to map their biodiversity. In "Resonant Echoes: Acoustic Heritage and Cultural Memory in the Mani Peninsula" George Edmondson, Penelope Bekiari and Anastasia Georgaki combine community engaged field recordings, ethnographic narrative and brainwave data to reveal the cultural significance and heritage value of the soundscape. In "Exploring the sonic tapestry of insular Greece: spatial capture and

systematic analysis of the Naxos' Island soundscape" Emmanouil Lianis, Giorgos Dedousis, Konstantinos Bakogiannis, Areti Andreopoulou developed an interactive virtual "sound-travel" map through a deep analysis on the impact of tourism on the soundscape of a Greek island.

Acoustic ecology and Soundscape ecology

In "Some Notes on an Ecology of Time", Peter Nelson explores how acoustic ecology links sound and time, showing auditory phenomena shape temporal perception and relational experiences in specific environments. In "Environmental Active Listening as a Form of Ecological Activism. Case Study: The Soundscape of "Pedion Areos" Wiktor Mastela, Areti Andreopoulou and Thanos Polymeneas-Liontiris advocate active listening as political practice of sonic activism in urban green spaces. In "A Hypothesis on the Influence of Ground Vibrations and Geophonic Sounds on Human Brain Activity", Gabriel Farilekas and Penelope Bekiari sonify ground vibrations to assess brain responses, finding natural low-frequency vibrations relax, while urban vibrations increase stress. Charikleia Minotou, Theofanis Maragos, Aristotelis Martinis, Aristotelis Filippou Skiadaresis and Spyros Kotomatas in "Highlighting natural and cultural heritage through soundscapes - Case study: the marine protected area of Gyros" analyse the development of an immersive audiovisual environment to safeguard the area's memory and heritage.

Soundscapes as a compositional framework

In "Sound Environment and Traditional Music in the Mountainous Pieria before Electrification", Thomas Apostolopoulos recalls pre-electrification rural Greek soundscapes, documenting natural and human sounds and their influence on local traditional music authenticity. In "Acoustic Futures: Eavesdropping on Dystopian and Utopian Possibilities" Luc Messinezis argues acoustic ecology and sound studies use past and present soundscapes to imagine, communicate, and shape possible future worlds. In "Oceanic ClimateScapes": A real - time sonification of aquatic physicochemical climate change data, set on marine soundscapes" Maria Kolia and Areti Andreopoulou combine culture, nature and performance in artistic sonification practices to enhance awareness of aquatic ecosystems. In "Utilizing soundscape analysis for site-related fixed media composition inspired by the acoustic environment and history of the Decauville route at Alona, Florina" Nikos Kokolakis explores the role of soundscape analysis in the creation of site -related fixed- media composition. In "Knud Viktor (1924-2013) – The Art of Listening", Julie Michel explores Knud Viktor's "sound images", combining field recording, electroacoustic composition, and deep listening to document Mediterranean biophony and geophony, contributing to the construction of a sensibility. In "Air and Sound: Historical Sound, Archaeological and Historical Data Transformed into Sound Art", Dimitris Bakas and Eleni Gerofoka present a sound installation linking historical data and the ancient hydraulis, transforming its air-driven sounds into an artistic, educational experience. In "The soundscapes of Kea as an auditory background for recording traditional instrumentalists" Theofanis Maragos, Georgios Konstantakis, Athanasios Epitideios, Apostolos Loufopoulos and Renata Dalianoudi document Kea's traditional musicians through soundscape-based documentaries, preserving intangible musical heritage using ethnomusicology, high-quality audio, and audiovisual methods.

Bioacoustics, biodiversity, and climate crisis

In "Bioacoustics and videogames as transformative media to engage the public in sustainability. Restoring blue carbon habitats in the Philippines" Ricardo Climent and Camille Rivera apply bioacoustics data and field recordings into climate-action video game development, emphasizing the reforestation and conservation of mangrove habitats. In "The Song of Blackbird»: a bioacoustic and musicological approach", Angeliki Kontopoulou, Panagiotis Syrios and Anastasia Georgaki examine Mediterranean blackbird songs, combining biological, musical, and cultural perspectives to understand their complexity, improvisation, and artistic significance. Dimitris Batsis in "EcoMuseum Zagori Soundscapes: Raising Awareness through Acoustic Community Interventions" describe an immersive narrative using soundscapes to tell stories of biodiversity, human - environment interaction and climate change impact on ecosystem. In "VLN_temp project: Music creation for violin and live electronics using sound sonification techniques to reflect global temperature changes", Dimitra Remidianaki and Anastasia Georgaki present a violin and live electronics composition using sonification to convey climate change data and raise ecological awareness through sound art.

Acoustic Ecology in education

Aimilia Karapostoli, Dimitris Giouzevas and Aggelos Tsaligopoulos in "The notion of soundscape in Architectural education; The case of two short design assessments in the studio" explore sonic ways in architectural representation. In "Program «Soundscapes of Taygetos»: From Sound Literacy to Ecological Literacy", Dimitrios Sarris outlines Soundscapes of Taygetos methodology, educational outcomes, and research showing climate

collapse impacts mountain soundscapes through water loss. In "Aural Inclusion: Bridging Sound Art and Technology for/with the d/Deaf and Hard-of-Hearing", Dana Papachristou and Yorgos Samantas present Audibility project, promoting inclusive sound art through Deaf-centered, multisensory practices and reimagining soundscapes as accessible cultural commons. In "Acoustic Oiko-topia: Educational aspects of collectivity and sustainability through sound", Andromachi Vrakatseli presents Acoustic Oiko-topia workshop using sound art education to foster acoustic justice, sustainability, and collective environmental listening among children. Renata Dalianoudi, Theofanis Maragos and Christina Sotiriou in the paper "From Field Recording to Hybrid Sound Narratives: Ecological Radio Documentary and Music-Pedagogical Echo-Stories" introduce the ethnographic ecological documentary drawing on field recording and sonic storytelling that can enhance also Environmental Education. In "The wetland of Vravrona. Case study of a recording of a threatened soundscape" Emmanouil Anastasiadis, Dimitra Agrafioti and Theofanis Maragos focus on the analysis of spatio-temporal soundscape variations in the threatened Vravrona wetland ecosystem in Greece.

Anastasia Georgaki, Chair
Areti Andreopoulou, Paper Chair
Andromachi Vrakatseli, Editor
Kostas Paparrigopoulos, Editor

Videos



Part 1



Part 2

A watercolor illustration of a dark bird perched on a branch, with the title text overlaid.

Soundscapes in Virtual and Augmented Reality

Integrating Soundscapes with Augmented Reality: Design and Implementation of a Geo-Located Audio AR App on the European Trail E4 on the Sitia Plateau

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Abstract

This presentation details the design and implementation of an audio augmented reality application for the European path E4, specifically the segment traversing the Sitia plateau. Developed in production of the Foundation of Research and Technology, this project aims to interpret the environmental and cultural heritage of the region, capturing also the essence of local life over time through the sounds. The motivation for creating this application arises from the need for a multisensory environmental perception and an enriched acoustic experience. The main purpose is to enhance hikers' experience by providing geolocated audio that conveys the historical and environmental narratives of the area, which are not immediately perceptible through direct sensory experience. The content of the application was developed after long term study of the area, interactions with the local population and extensive multi-day field recordings. To support educational engagement, an accompanying usage plan for primary school students was developed, proposing activities and suggestions based on Acoustic Ecology principles. Furthermore, the presentation will cover the outcomes of the demonstration of the app in a group of educators from across Greece and two local student groups. These sessions highlighted the application's potential to enrich environmental perception and foster a deeper acoustic experience.

Keywords

Audio augmented reality, soundscapes and intangible cultural heritage, augmented travel guide

1. Introduction

In the contemporary landscape, we are experiencing an era of intense acoustic and technological complexity that reshapes our relationship with the world and our perception of the environment. Rapid technological advancements and the diffusion of digital technologies often limit the multisensory perception that deepens human experience. Amidst these conditions, important questions arise regarding our stance toward this reality. How can we ensure that we cultivate a multisensory perception of the world, one that includes auditory experiences, without neglecting the possibilities offered by contemporary technology? In what ways can we creatively harness the potential of technology to enrich our perception of space and sound without distancing ourselves from mindful listening and experiential engagement with the environment?

In this context, augmented reality (AR) emerges as a promising tool in the quest for multisensory experience and a deeper connection to space. In recent years, AR has become a powerful form of digital interaction, applied in various fields such as education, tourism and cultural management. Audio AR introduces a new axis for enriching user experience by placing sounds at predefined points within a space, emphasizing the acoustic dimension of information. Research in the field of acoustic guided tours suggests that locally anchored acoustic experiences strengthen the visitor's connection with the environment, enabling a more immersive and personalized understanding of the historical and cultural value of a location (Billinghurst et al., 2015; Boboc et al., 2022).

This presentation focuses on the design and development of an audio AR application for hikers on a section of the European Trail E4, traversing the Sitia Plateau (e4Waterways app). Developed in collaboration with the Institute of Computer Science of the Foundation of Technology and Research, this app is part of the Interreg Greece-Cyprus European Program "Waterways and Stories on E4 and in the Geoparks of the Eastern Mediterranean - WATERWAYS". Its goal is to enhance the multisensory experience of natural and cultural landscapes, leveraging digital technologies to preserve and interpret acoustic heritage in an engaging and educational way for modern users. Moreover, to align the app's use with educational purposes, an educational scenario was designed for primary and secondary education based on the principles of Acoustic Ecology. Finally, the presentation also includes initial pilot actions involving the app's use with groups of adults and children during its development phase.

2. Acoustic Ecology and Audio Augmented Reality

Acoustic Ecology perceives sound as an essential element of human spatial experience, with the capacity to shape our perception of the environment and enhance our connection to it. This approach also aims to cultivate an auditory awareness that recognizes the complexity of sounds. From this perspective, Acoustic Ecology provides a suitable framework for integrating augmented reality, not merely as an additional element but as a tool that highlights and harmoniously integrates into the existing soundscape. In augmented reality, space is not only presented through visual data but is enriched with soundscapes that emerge in real time, creating a multisensory experience that invites the user to connect emotionally and diversely with the landscape (Gaye et al., 2003). The role of the acoustic environment as an "invisible guide" is elevated, shaping the meaning and personal connection to the space.

Focusing more closely, geo-located audio augmented reality refines this experience through precise positioning. Sounds are no longer merely atmospheric but are specifically integrated into the environment, offering a historical and cultural dimension to each place (Hazzard et al., 2014). For example, in an archaeological site, sonic echoes of the past could be revived, with sounds such as ancient voices, tool noises or subtle environmental whispers activating according to the user's position. This acoustic interaction functions not only as a narrative tool but also as a medium for education and the preservation of intangible cultural heritage. Audio AR aligns with the objectives of Acoustic Ecology, inviting us to "listen" again to the world around us, not just through hearing but through a deeper emotional engagement (Kendall, 2010).

One of the fundamental practices of Acoustic Ecology, the soundwalking, offers, as defined by Schafer, a conscious auditory experience where participants actively observe the surrounding soundscape (Schafer, 1994, p.213). Within the context of audio augmented reality, the soundwalk is enhanced by the ability to embed additional sonic elements related to the cultural, historical, architectural or environmental identity of the place. By placing specially designed sounds at specific points, participants have the opportunity to experience a sound environment that is not only present but also "overlaid" with elements from the past or the imaginary (McCartney, 2010). This approach promotes conscious listening and connection with the soundscape, fostering a deeper, interactive relationship with the space.

3. Audio Augmented Reality and Acoustic Guided Exploration

Audio augmented reality (Audio AR) has evolved into a sophisticated tool that enhances acoustic tours, expanding the experience beyond traditional narration. Instead of being limited to static information, Audio AR dynamically enriches the sound environment, allowing sounds from the imaginary, the past and the present to coexist based on the user's position and movement in space (Billinghurst et al., 2015; McCartney, 2010). This layered approach, which blends real-time ambient sounds with historically informed elements, transforms users' perception, immersing them in a narrative-rich soundscape that resonates with the immediate environment (Dedousis et al., 2021). This form of guidance offers visitors the feeling of being "within" the history and cultural background of a place, deepening their cultural and emotional engagement (Boboc et al., 2022).

In natural environments, acoustic tours through Audio AR strengthen users' connection with the landscape, positioning the soundscape as an active component in their experience. In areas like the European E4 trail, where nature and its sound environment play a vital role, Audio AR introduces a new form of conscious listening. Users can "listen" to imagined soundscapes as they are activated in real-time according to their location, creating a dialogue between natural and technological sound (Gaye et al., 2003; Hazzard et al., 2014). In this way, sound

reality deepens the understanding of its ecological and aesthetic dimension, enriching the user's overall experience of space (Augoyard & Torgue, 2005, p.8). Furthermore, audio augmented reality can incorporate a critical perspective into acoustic tours, serving as a medium for highlighting and commenting on social and environmental issues, utilizing technology's potential as a tool for social critique. Through this application of audio AR, issues such as the alienation of the acoustic environment in areas with wind power farms can be brought to the forefront, offering users an experience that not only connects them with nature but also encourages reflection on the consequences of human interventions in the natural landscape (Farman, 2020). This technology holds the potential for a conscious interaction with the environment, emphasizing the cultural and social dimensions of space and inviting users to reflect on the role of technology in the daily experience of place.

4. Application Description

The e4Waterways application, designed for Android smart devices (Android 12 and newer), enables a geo-located audio-augmented route. To activate real-time navigation, the user grants location data access and subsequently receives audio cues as they approach points of interest along the route. Without the necessity of headphones, the user can listen directly from the smart device to audio clips—sometimes realistic, sometimes imaginative—that highlight natural, historical and cultural landmarks. This approach enhances the immersive experience of the soundwalk, strengthening the visitor's connection with the environment. The user is also given the option to pause or replay the audio clip at any time. Additionally, the application supports remote exploration through a digital sound map of the route.

5. Design and Implementation of the Application

The creation of the audio-augmented reality application for the Chandra-Voila trail was based on a series of stages, following a holistic and interdisciplinary approach. The first stage involved historical and cultural research of the area, in collaboration with the Ephorate of Antiquities of Lasithi. Historical records were studied regarding the evolution of the population and the history of the region, including monuments such as the ancestral tomb of the poet Dionysios Solomos in the abandoned settlement of Voila. The research also explored the area's musical tradition, highlighting its primary differences from the traditions of Western Crete.

The next stage involved visiting the area and participating in the daily life of the village of Chandra, located at the center of the trail's area of interest. A multi-day field research was conducted, focusing on recording daily soundscapes and deepening understanding of the local culture and traditions. Throughout the day, the sounds of village life were documented with continuous field recordings and soundwalks. Efforts were made to capture the acoustic "texture" of local customs and social life by living alongside residents during their daily activities, including tasks such as milking with shepherds and assisting in the village church. Guided by the village's former school principal, an amateur folklorist who has been a resident for the past 65 years, numerous visits were conducted to sites of natural interest. An extensive three-part interview was also conducted, in which he narrated stories and highlighted issues related to the village's history, cultural heritage, traditions, natural resource management, past occupations and the challenges of desertification in the area. Special attention was given to recording sounds from the wind farm located within the area of interest. Following interactions and discussions with wind farm workers, recordings of the turbines were made from various points, using specialized microphones such as contact microphones, geophones and ambisonic microphones, capturing both external and internal sounds from the turbines. This sound recording highlighted the dynamic contrast between the natural landscape and technological intervention, adding a critical dimension to the acoustic portrayal of the trail. Through this intensive process of participation and observation, a rich sound archive was gathered, capturing the contrasts and combinations characterizing life in the area, enhancing the authentic nature of the application.

After the field visit, specific geographical points along the trail were selected for inclusion in the sound map and subsequent use in the application. During this stage, reflection was conducted on the historical and cultural research, field observations and field recordings to determine the points that would offer a rich and multi-dimensional auditory experience for visitors. Each point was selected based on its historical and natural significance, cultural value and acoustic interest. Among the fourteen selected points was a small forest that serves as a stopover for migratory birds, specifically hoopoes, during their journey. Also the location of the ancestral tomb of Dionysios Solomos' ancestors within a church in the settlement of Voila was included, adding a historical and emotional dimension to the auditory journey. The central square of Chandra, where the largest

mosque of the area stood during the Ottoman period (now without any visible marker), was another selected point. Nearby, there are two additional sites featuring a ruined Turkish bath and Venetian fountains, monuments closely linked to the historical relationship between water and daily life in the area. Lastly, a significant point along the trail is the section impacted by noise pollution from the wind farm, emphasizing the contrast between the natural landscape and industrial installations, raising questions about the effects of human intervention on the acoustic environment. The route of the points of interest along the E4 trail was designed to provide application users with a narrative that combines nature, history, tradition and contemporary social reality, reinforcing their sense of connection with the place and its past.

During the sound clips of the app creation stage, emphasis was placed on sound design, aiming to capture the acoustic identity of the area in a way that enhances users' immersive experience. This process included the use of field recordings gathered during the field research, as well as the integration of traditional Cretan musical instruments combined with electronic sounds to create a multi-layered sound palette. Additionally, narratives based on local stories and testimonies, as well as vocal improvisations, were added to provide a personal touch to the compositions. The sound clips were designed to vary in character, sometimes realistically depicting local soundscapes and other times incorporating imaginative elements to convey the atmosphere and cultural heritage of the area. In some cases, compositions were created that combined real sounds with fictional soundscapes, offering a dreamlike quality that invited the user to engage in a deeper, mindful listening. The goal was to create an immersive auditory experience that enhances the visitor's perceptual connection to the natural and historical environment of the trail, enriching the application with an emotional and aesthetic dimension.

The final stage involved the development of the application, implemented by the Systems and Networks Department of the Institute of Research and Technology. The application was specifically designed for devices with the Android operating system (version 12 and later), integrating geolocation capabilities and leveraging Google Maps to design a sound map with precisely placed audio points of interest. Implementation was based on the Java programming language, ensuring the stability and functionality of the application in real-world usage conditions. Upon completion of the development, the sound clips were uploaded and integrated into the application, making it available for use, with the audio stimuli accurately positioned at geographical points of interest in the area. Following the completion of the technical aspects, pilot tests of the application were conducted with user groups from the public, aimed at identifying potential technical errors or malfunctions, as well as gathering feedback.

6. Pilot Testing of the Application with User Groups

The pilot testing phase of the application consisted of three distinct pilot presentations conducted over a four-month period, aimed at extensively evaluating the functionality and pedagogical effectiveness of the audio-augmented reality system. These tests sought to assess the user experience across different audience groups and to provide valuable feedback that would contribute to the enhancement and development of the application. As the application targets a diverse range of users, the pilot tests were designed to incorporate responses and suggestions from both middle and elementary school students, as well as adults and educators, thereby allowing the integration of varied needs and expectations into the design of the final version.

The first pilot test was conducted in collaboration with the Environmental Education Center of Ierapetra and the Unesco Sitia Geopark, involving two student groups from the local middle school. Guided by their teachers, the students had the opportunity to interact with the application in a familiar environment, yet they discovered new dimensions of the soundscape and the region's cultural heritage. The reactions and feedback from the students regarding usability and user experience provided valuable insights into the needs of this particular age group, aiding in the adaptation of the application for younger users.

The second pilot test took place as part of the 3rd Summer School on Environmental Education at the Sitia Geopark, with the participation of thirty educators from various regions of Greece. The teachers evaluated the application from an instructional perspective, focusing on the effectiveness of the soundscapes of apps' sound clips as a tool for environmental awareness and experiential learning. Feedback from this group emphasized the value of the application for environmental education and suggested additional features to enhance its interactivity and educational impact.

The third and final pilot test was conducted with students from an elementary school in Sitia, who explored the application under the guidance of their teachers. This younger group expressed enthusiasm for the audio vignettes and the way these soundscapes brought the landscape to life. These three pilot tests were crucial in

reflecting on the overall user experience and evaluating the application, providing significant feedback for technical and functional improvements, such as resolving the issue of "overlapping" two nearby points on the map. The results of the tests underscored the importance of adapting the application to meet the needs and expectations of diverse audience groups, ensuring that the final product delivers a comprehensive and interactive user experience that fosters environmental and cultural awareness. Finally, an impressive aspect of these pilot tests is the absence of negative feedback regarding the technological mediation of the nature walk, both from the student audience and the adult participants.

7. Educational Integration of the Application

In an effort to support versatile and inclusive use of the application within the educational community, an educational scenario was developed to accompany the e4Waterways app, which integrates augmented audio reality with environmental education and listening skills. Based on the principles of Acoustic Ecology, this scenario focuses on cultivating students' conscious listening and awareness of the soundscapes of natural and anthropogenic environments. It aligns with subjects such as Geography, Environmental Education and Music, encouraging an interdisciplinary approach that connects nature with sound art and the cultural identity of the landscape. The application serves as a tool that enhances students' auditory experience of the natural landscape, specifically within the Chandra – Voilas section of the E4 trail, fostering their experiential connection to the environment through geolocated sounds. Targeted at students aged 9-15, with the option to adapt for younger or older groups, it encourages appreciation of the auditory experience and recognition of sounds and soundscapes as significant elements of spatial identity. The scenario spans four sessions, each lasting 60 minutes, and provides various teaching resources and online tools as well as the e4Waterways app itself for implementing the sound walk. Teaching is based on the interdisciplinary approach outlined in the National Interdisciplinary Curriculum Framework and Analytical Curriculum for Primary and Secondary Education (2003), with an emphasis on creativity, student-centered pedagogy, cooperative learning and active participation.

During the first introductory session in the classroom, students are introduced to the concepts of listening and sound observation through sound games. The second session includes a sound walk on the Chandra-Voilas trail using the app, allowing students to experience geolocated sound moments in the natural setting. The educator may provide additional information for each sound, further enhancing students' experiential connection to the environment. The sound walk and second session conclude with students designing individual sound maps. In the third session, students return to the classroom to recreate individual sound maps, this time of the classroom itself. They compare the sounds of the classroom with those of Voilas, analyzing the differences between natural and human-made sounds. Through mime and movement activities, they express their impressions, fostering creativity and critical thinking. Finally, in the fourth session, students are invited to create an imaginary soundscape with air sounds under the teacher's guidance, followed by an improvisational interaction with a composition of soundscapes from the specific area. A reflective discussion follows, exploring the concepts of soundscape and sound walk, focusing on understanding the auditory identity of the place and the information conveyed by sound. The session concludes with a collective sound game, reinforcing a sense of community participation and auditory awareness.

8. Discussion

The design and development of the e4Waterways application for the E4 trail in the Sitia Plateau highlighted the potential of Audio Augmented Reality to enhance users' connection to the natural and cultural landscape. By integrating the principles of Acoustic Ecology, the application enables users to "listen" to the space in real-time, without headphones, experiencing the environment alongside its natural sounds. This approach encourages mindful listening, allowing users to freely interact with the soundscapes, which they can replay or pause at any moment, thus deepening their multisensory perception of the landscape. Pilot tests with students and educators revealed important insights into the functionality and educational value of such applications. Students had the opportunity to experience a new form of auditory exploration, while educators recognized the application's potential as a tool for experiential learning and environmental education. Additionally, the integration of recordings from the wind farm, which raises questions about sonic alienation, introduced a critical dimension, rendering the application not only educational but also a medium for environmental and social reflection.

Based on the research, design and implementation of this project, it is considered that Audio Augmented Reality has the potential to evolve into a powerful tool that combines technology with experiential and environmental

awareness, especially through the principles of Acoustic Ecology. By embedding Audio AR into environmental and cultural contexts, users can engage in an experience that does not distract them from their acoustic environment but instead invites them to become active listeners within it. The possibility of open listening, without the use of headphones, enhances this experience, as it allows users to spontaneously connect with the natural sounds of the location, choosing when and where to interact with the soundscapes. In the future, this technology could incorporate interactive features, such as capturing users' auditory perceptions or adding personal audio “notes,” thus creating an evolving auditory database that reflects the changes and experiences of people in the landscape. With such an approach, Audio Augmented Reality can offer not only new educational and augmented reality explorational possibilities but also a deeper reflection on the acoustic alteration of the natural environment, encouraging users to become mindful listeners and conscientious stewards of the soundscape around them.

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Interactive electroacoustic music - the concert space as an ecosystem: *The Mon Repos Augmented Soundscape Project* - A site specific sound installation in a dialectic with its environment

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Abstract

The main objective of this project is the design, development, and implementation of a platform for creating interactive electroacoustic music works and sound installations that reshape the relationship between organized sound, the environment, and the audience. A platform for creating technologically augmented sound ecosystems is proposed, with an emphasis on open space applications that will incorporate sounds from the biological and geological dimensions of the sonic environment as well as human activity within a holistic soundscape. The basic concept is to consider the concert space as an ecosystemic unit, with integral elements being the human audience-participants and the natural environment, and where sound becomes the medium for communication between different lifeforms (human or not) and artificial agents simultaneously producing and (maybe even) coordinating sound in this space. The Mon Repos Augmented Soundscape Project, described here, is a first attempt at implementing such a system in the form of a site-specific sound installation. It took place on June 2022 within the area of the Mon Repos urban forest in Corfu, Greece.

Keywords

Interaction, electroacoustic music, shared sounding space, ecosystem, acoustic ecology

1. Introduction

The main purpose of this work is to propose a set of tools for implementing soundscape and electroacoustic composition and performance in a way that is aware, respectful and in a dialectic with natural environments within which a concert can take place. The principle here is not to impose sound onto a space, as in the case of a typical concert, but rather to inject sound within it as an interaction between various lifeforms (biological and artificial) inhabiting this space, hopefully engaging in reciprocal dialectic relationships by means of sound. The project draws inspiration from ideas of composition and interaction seen as an ecosystem, as proposed principally by Agostino Di Scippio in his *audible ecosystems* (Di Scippio, Hörbare Ökosysteme, 2005) and other works, by David Tudor's various iterations of Rainforest (Janevski & Joseph, 2019), and also from a personal need to take electronically produced sound and music out of the concert hall into the open air, and integrate it with natural soundscape. For related work, see also the sound installations of Jean-Mark Duchenne, based on large numbers of small speakers (Duchenne, n.d.), the wilderness interventions with portable electronic instruments of (Greie-Ripatti & Bovermann, 2017) and the *Fielding* project (Bovermann, 2017) where human and non-human performers shape and form an artificial soundscape by incorporating environmental sensors (temperature, moisture, light) into the music making process in nature.

2. The concert space as an ecosystem

Any musical concert can potentially be viewed as an ecosystem in the sense that no matter how pre-defined and controlled the roles of the conductor, the performers, the audience and the acoustics of the concert hall are, there is always some sort of interaction between these and all of the additional human agents (the audience) occupying the same space and the total experience lived by any single agent depends, to an extent, on the sum

of all the parts. Different types of concerts may have different thresholds and modes of desired interactions between these agents. A loud, active and dancing audience for example is desirable (and a big part of the experience) in a rock concert but not in a classical one where an audience is cultivated to listen quietly and attentively. In any case though, and regardless of what kind of sound (or behavior) can be considered intrusive, concerts of that kind focus on a number of factors that have to be controlled in order for the main sonic event produced "on stage" to be experienced. Preventing sounds from outside of the concert venue from entering the interior sonic environment becomes the more important of these factors. However, there will always be distracting sounds that cannot be easily controlled, like "that odd cough" from the audience for example.

By "taking" the concert out of the concert hall and into an open space with its own active soundscape, musically organized sound inevitably comes into interaction with the surrounding sonic space in terms of how it is perceived. Our model takes this into account and uses it as a feature to make this interaction a defining factor of the musical organization of sound as a whole, a sonic ecosystem of all the factors producing sound at the specific time and space. Of course, this kind of interaction can also develop equally indoors, where in general less complex soundscapes exist. However, outdoors sonic environments are potentially more resistant to control and therefore more interesting to explore as sonic interactive systems. A concert designed to utilize all of its participants through their sounds (whether these belong to the human, biological or geological dimensions or to some machine "artificial intelligence") to form or shape its content has to consider the interface between them. That is the common "language" by which they interact to form a composition, and we can assume that most of them are not proficient in it in order to control it – in fact some may not even be aware of its existence. As Agostino Di Scipio puts it, citing (Hamman, 1999), "The interface design becomes the very object of composition" and continues, to add that "the array of DSP algorithms, and the methods by which they communicate among themselves, should be seen as the material implementation of a compositional process or concept" (Di Scipio, 2003, p. 270). "The very process of 'interaction' [...] seems to be, in living organisms (either human or not, e.g., animal, or social), [...] a by-product of lower-level interdependencies among system components" (ibid., p. 271). Di Scipio is primarily concerned with emergent structures out of these interactions as a means of producing macrostructure in composition (Meric & Solomos, 2014). In a concert setting however, where a curated collection of compositions is being performed in a specific space and time, the compositions - as autonomous entities - are essentially acting as agencies, in addition to all the other soundscape participants. Our goal in this case is to provide tools to enable such sonically organized material to come into a dialectic relationship with the environment in which it exists, rather than engaging in a monologue. Put another way, to make these agencies aware of, attentive and adaptive to their surroundings.

The project in concern here is part of ongoing research on the sonic interaction between biological and artificial agents within the natural environment of the first, into which the sound producing (or transforming) artificial agents adapt in order to collectively produce or augment a "concert" in real time. The core of the research focuses on the design and implementation of a decentralized network of hardware-software units based on small battery-powered electronic and computing devices (such as smartphones¹, Raspberry-Pi type embedded computers, microprocessors etc.). Units in this network can use machine listening techniques to perceive their sonic surroundings, collect sound data, recognize relevant sonic patterns and respond by synthesizing or manipulating sound material in real time. Sound from each such unit is locally reproduced by one or two small battery-powered speakers and the whole hardware is hidden on trees, in bushes or merged into other features of the environment. An ecosystem of such units (of possibly differing design each) is collectively contributing sound to the overall system - participating in a dialectic process within the local space, involving lifeforms or other artificial units sharing it - resulting in a dynamic and constantly evolving soundscape within the broader concert space.

¹ i.e. readily available, very small, battery powered computers – also a nice way to reuse old phones that would otherwise end up in the dump.

3. The Mon Repos Augmented Soundscape Project

In the specific implementation of the *Mon Repos*²*Augmented Soundscape Project* that took place during the *Akoysmata 2022* festival³, and which concerns us here as a case study, a core set of programming tools (mainly in the form of pure data⁴ patches to be run on portable computing devices) was provided to a number of artists (see Table 1) who were free to use, modify, extend and otherwise compose their contribution to the system on a local level each. The core software (see Figure 2) provided analysis tools for the pitch and loudness content of the soundscape as well as access to a smartphone’s built-in sensors such as the accelerometer. Some of the implementations attempted some form of interaction with the local soundscape while others injected algorithmically produced, or fixed, composed sound inspired by it. The guidelines given to the artists were minimal. 1) To respect the natural soundscape and augment it seeking an ecological balance (Truax, 1984) with it, not overpower it with sound louder or denser than the natural one. The work should seek some form of a dialectic relationship with the environment it sits in. 2) Each installation should use minimal equipment that is powered from batteries (off-grid) and hidden away from sight. It should be easy to install and remove, with no trace on the environment left of it when gone. 3) If there is a need for a visual element, it should be small scale and integrated with the surrounding environment.

Spot #	Composer	Type of work	Spot characteristics
1.	Andreas Monopolis	DIY hardware	Main footpath
2.	Giorgos Lambropoulos	Interactive	Hidden away, small forest clearing
3.	Ioanna Mavriki	Fixed medium	Abandoned building at the end of a footpath
4.	Philippos Theocharidis	Algorithmic	Forest opening with three huge Ficus trees
5.	Andreas Mniestris	Fixed medium	Dense forest but audible on nearby footpath
6.	Philippos Theocharidis	Interactive	Dense forest but audible on the nearby main footpath
7.	Dimitris Matsoukas	Algorithmic	Building ruins on a main footpath

Table 1. Composers, work types and installation spot main characteristics within the forest

Each composer selected a spot within the forest and was responsible for setting up their own equipment and “sonic intervention space” as desired (see Figure 1). The specific spots were chosen after a series of preparatory sound walks in the area, where the artists would take the time to meticulously listen and collect sound and other data needed to prepare their works.

The installations took place during a whole day in June, closing at around 8pm which at this time of the year is still mostly daylight. The “audience” members wandered freely within the space, altering their perspective within the overall soundscape while simultaneously, knowingly or unknowingly, participating in it. As the forest is freely accessible to everyone, this “audience” comprised of people who knew there was something going on and people who didn’t⁵. Some were just hiking, cycling or on their way to a nearby beach. Birds, small animals and insects of the forest were also essentially members of this “audience-participant”.

A variety of implementations regarding the form of acoustic intervention were used in the project, the choice being up to the respective composers. Most of them used smartphones running software based on the given Pd patches and the sound was projected into the local space using small, low power, Bluetooth or wired speakers. The equipment was hidden in trees, bushes and other features of the specific location and care was taken regarding the amplification level, to not overpower the natural soundscape as heard from a distance. One of the

² The Mon Repos is a well-known forest area within the town district of Corfu, Greece. Although it is pretty busy during spring and summer with people taking a walk on its main footpaths, there are also lots of densely forested quieter spots, populated by various birds, as well as places of archaeological interest. The sea is also nearby and therefore ships and smaller boats passing-by occasionally contribute to the soundscape.

³ <https://avarts.ionio.gr/festival/2022/en/akoysmata/>

⁴ Or Pd from now on, <https://puredata.info>, open-source visual programming language for multimedia by Miller Puckette 1996-2024. The software for the installations was running on smartphones via the open-source applications PdParty by Dan Wilcox (2011-24) <https://github.com/danomatika/PdParty>, or Timothy Schoen’s (2023) plugdata <https://plugdata.org>.

⁵ There were QR codes printed out and stuck on a small number of trees around the area which linked to a google maps page with the spots marked on it (see Figure 1).

sound installations did employ a visible element and it was located on one of the main entrance footpaths (spot #1 in Figure 1) leading to the other spots, acting as an introductory cue to passers-by that something may not be “as usual” in the forest today.

The installation itself was based on a collection of D.I.Y. hacked electronic hardware⁶; small battery powered radio receivers hanging over the pathway, transducers stuck on footpath labeling signs and various other small micro-noise producing devices scattered around the place that injected human activity and machine produced sound into the forest soundscape.

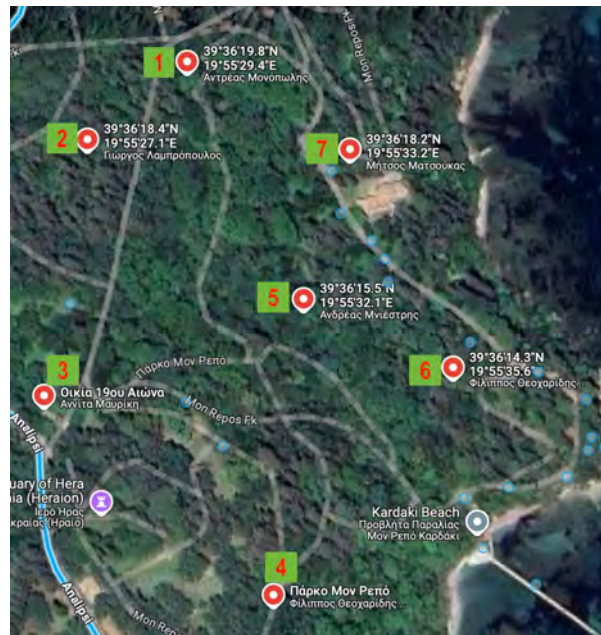


Figure 1. Spots with sonic intervention within the Mon Repos urban forest

An interactive sound installation inferring ambient sound loudness using a smartphone’s mic level (relating to the noisiness / busyness in the surrounding environment) and wind strength data (using the accelerometer to detect micro-movement when hung from a thin tree branch) was playing in spot #2. Sonic material derived from recordings of reptiles (predominantly snakes) and domesticated animalia (mostly chicken coop sounds) was mixed in response to changes in the sensors’ data. The works installed in spots #3 and #5 were for fixed medium, playing at random occasions, between 50% and 70% of the whole time. Their compositional material was related to the specific site characteristics they were installed in (see Figure 1); that was mainly domestic / household sounds in spot #3 and wildlife sounds in spot #5 (see Table 1). Although there was no real-time interaction with the surrounding soundscape designed into these compositions, the composers relied on the careful preparation and processing of the material they had gathered in the listening / recording phase of the project in order to build a connection to the place. They both aimed at augmenting the sonic perception of the passer-by while also providing a site-specific narrative for the more attentive listener to follow. In spot #4, insects and birds from Japan were algorithmically mixed with drone sounds derived from recordings of human made constructions in the country’s gardens and forest parks, such as automatic escalators or teleferics. These non-native sounds were “transplanted” to the Mediterranean environment, echoing a sonic “migration” of exotic species (as well as machinery not typically found in such places). This alien but, at the same time, natural-sounding sonic environment draws an analogy with the three huge Ficus trees that are very characteristic of this open space in the forest which look very distinct, almost otherworldly, in comparison to their surrounding flora (see Table 1). The density of the composed soundscape was related to the density of the natural soundscape in real-time. When more things happened (people talking, birds, boats, planes passing by), more sound was generated, adding to the complexity in the resulting soundscape. In #7, sonic material was based on algorithmically generated birdsong-like melodies coming from within the ruins of an old church side-building.

⁶ In the manner of John Richards’ “dirty electronics” (Richards, 2008) and similar practices.

Sound in installations spots 2, 3, 5, 6 and 7 was monophonic, producing a single sound source image hidden in places away from the main footpaths and relying on reflections from nearby trees / walls etc. in order to blend into the surrounding ambience. More discrete sound sources / channels were used in installations #1 and #4 reflecting on the larger, more open spaces they were deployed in, in order to produce a larger sound image.

4. Towards an interactive dialectic with the surrounding soundscape

The installation in spot #6 was the most adventurous in terms of the interaction attempted with its local soundscape which was dominated by the sounds of a variety of birds, as it was in a dense and pretty inaccessible part of the forest; but also, occasional sound from passers-by, as the nearby pathway was audible if humans (or their pets) crossing it were loud enough. We will describe the interaction mechanisms employed in this work as a first attempt at designing a system that can gather meaningful data about the soundscape it is installed in and interact with it in novel and compositionally relevant ways. The hardware apparatus of the installation consisted of a smartphone connected to two small battery powered speakers at a distance of ~10m apart from each other. All three devices were hanging on trees. On the software side, pitch contour data was gathered from sound picked up by the phone’s mic in real-time. This data was used to synthesize artificial birdsong-like patterns in response to the auditory features in the soundscape around it. Two “birdsong generator” algorithms (using simple, two operator FM⁷ synthesis) were used for the sound synthesis and these were panned to the two speakers respectively so that the produced sound would appear as if it was coming from two point sources on the trees. Only one of the two generators responded at any one time and the timing of this response was related to the density of the events in the surrounding soundscape. The top-level patch as it appears on the phone screen is shown in Figure 2.

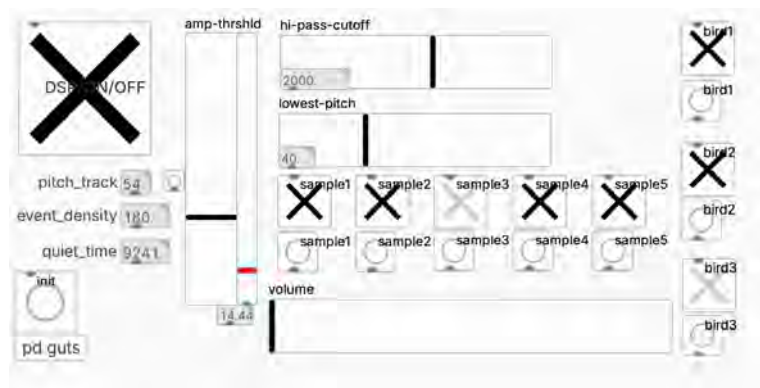


Figure 2. Main view of the template Pd patch provided for the installations. Parameters accessible from the main screen are as needed for setting up on a specific spot once and then left alone. Main Volume, switches and activity monitors for the various generators and controls for the pitch / event tracking: Threshold, hi-cut filter and lowest detected pitch to output

Pitch tracking (see Figure 3) was implemented using the [sigmund~] object in Pd, set to an analysis window of 1024 samples for a relatively fast response and CPU performance, given the limited processing power of an average mobile phone. A simple algorithm to ignore sounds coming into the microphone at a level lower than a threshold and a hi-pass filter was used to condition the signal going into the pitch tracking algorithm in order to favor birdsong type sounds and ignore wind rumble and ambient noise. Sound produced by the currently playing generator was also filtered out of the pitch tracking algorithm (for each one of the generators respectively) by muting the microphone input for as long as it was playing. This was necessary in order to prevent a generator from tracking its own pitch and responding to itself. One generator however could respond to sound produced by the other - as well as natural sound input. Continuous pitch data was stored in an array and this was used to set initial pitch envelopes for the generators.

⁷ Frequency Modulation, as pioneered by John Chowning (Chowning, 1971).

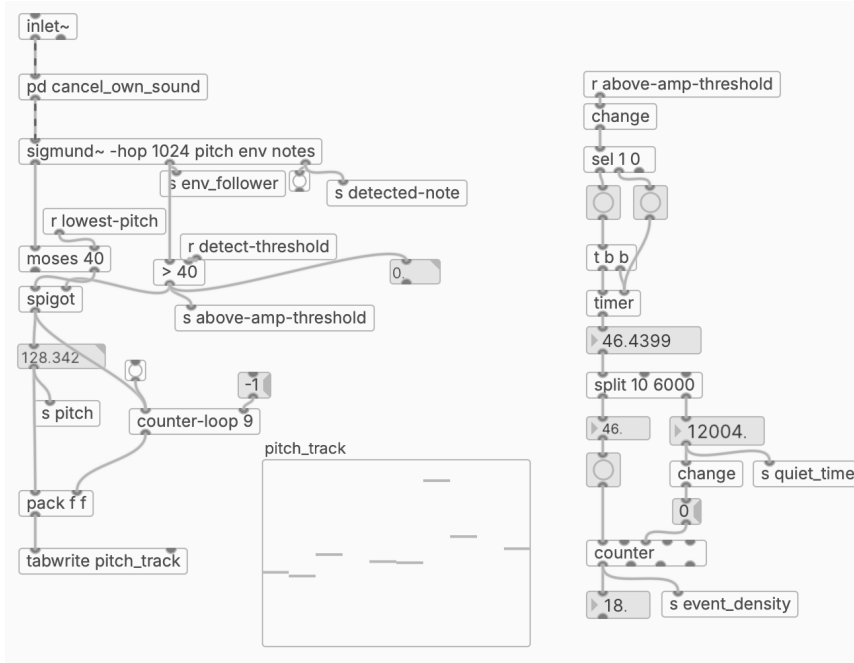


Figure 3. Pitch / event tracking algorithm

Variation in the response’s pitch was achieved a) by adding small randomization functions to the synthesis and b) as a byproduct of possible errors in the pitch tracking. In this way the pitch envelope of the response kept some resemblance to the “heard” birdsong, while not mimicking it completely. The macro (general amplitude envelope shape, speed of response) and micro timing (internal phrasing) of the response was determined by an algorithm utilizing controlled randomness, the magnitude of which was dependent on the loudness and density of “gestures” and tracking events in the input sound. A “gesture” was defined as follows. The number of tracking events detected above the threshold during a time window were counted (see Figure 3, on the right-hand side of the patch). This time window was reset every time there was a lack of events for more than 6 seconds. Events after this would belong to the next “gesture” and so on. Dense gestures (comprised of a lot of events) would trigger a faster response with denser internal phrasing (shorter times between new pitches produced).

The main type of sounds expected at the input of the system at the spot installed was birdsong but of course it also responded to any other audio input that passed the amplitude and frequency spectrum thresholds set on site. Another common class of sound that could end up as input events to it was human voice, usually originating from the nearby footpath to the beach. This would result in a bird-like response of the machine that resembled the pitch variations of the voice. An attentive listener could therefore actively sing to it and jam with the “bird”. Our deepest hope would be that this “attentive listener” could also be non-human.

5. Conclusions - Further work

In the project discussed above, the machine’s reactions are based on data derived mainly from pitch tracking. While pitch contour would seem to act as an important factor in the communication between birds for example, other factors - such as timbre variation - can possibly also be of great importance in order to transduce meaning through sound in other species, as could be suspected from (Weisman, Mewhort, Hoeschele, & Sturdy, 2012) for example. For such a system to interact in some possibly meaningful way with all sound producing agents in an environment, other audio features need to be taken into account as well. Greater computing power available in more modern mobile computing devices allow for more generalized methods of machine listening to be implemented. More recent versions of the algorithm currently being developed and tested, are based on machine learning techniques, using tools such as the FluCoMa library (Tremblay, et al., 2022) as well as utilizing the harmonic analysis data available from [sigmund~].

In this direction, research in fields such as biomusicology and animal linguistics [for example (Snowdon & Teie, 2010), (Ritvo & Allison, 2014), (Gupfinger & Kaltenbrunner, 2018), (Berthet, Coye, Dezechache, & Kuhn, 2023), (Suzuki, n.d.)] can be relevant. It can enable a better understanding of the other biological agents’ viewpoint on

an artificially "augmented soundscape" like the one proposed, and therefore provide valuable insight in aspects of its design. What does it mean for other species to hear sounds that mimic (and also extend in a novel but abstract way) their own? Could they possibly find a connection? Could they establish some sort of meaningful (to them) interaction with such artificial agents? Also, can technology of this kind develop a dialectic, bearing meaning, with other species by adapting its sound producing behavior (and in the case that it can, would this type of communication be comprehensible to humans in some way)? Having said that though, maybe art should be able to produce meaning beyond "what makes sense" verbally, so it is not our primary concern (and maybe a long shot too anyway for the current state of the art) so long as it at least does not inadvertently scare away, or in some way annoy, our non-human (and let's not forget, also involuntary) audience/participants. Loudness is also an important factor which needs to be carefully considered in this sense.

From a human audience/participant's perspective, the macroscopic organization of time and space in *The Mon Repos Augmented Soundscape Project* was left completely open. The sonically augmented spots were spaced in a relatively large geographical area and people had to walk from one spot to the other. The spots were also pretty much sonically isolated from each other, classifying the whole event as a site-specific sound installation rather than a composition or a concert. Therefore, it was up to the individual to employ different levels of listening (and participation) engagement or to just walk away uninterested. Although no formal data about attendance, active participation, etc. were collected or any questionnaires handed, quite a few people (although still a minority) were observed to care about and actively take part in this augmented soundscape and we received quite a lot of voluntary verbal / empirical feedback. Most of them could not deduce a meaningful "dialectic" from their interaction with the virtual lifeforms installed in the forest but still enjoyed jamming with them anyway and also inspired them to try it with real ones as well. The majority of the people we talked with, stated that the fact that the soundscape during their daily walk was "twisted" or "strange" in places, made them more attentive to it in general and inspired them to engage in a deeper state of listening (Oliveros, 2005) even in parts of the forest with no artificial intervention. Everyday sound that would usually go unnoticed as part of the background became a feature to "listen out" for. Others were also incited to take a longer walk than they usually would, taking detours from their course just to discover the sounds in the forest, virtual or natural. No scientifically relevant data as to the effectiveness of the project in this sense can be deduced by such comments of course, as these were by people who actually cared to come and talk to us. Most of this is probably what would one do in the context of a typical soundwalk (as pioneered by Hildegard Westercamp in the 70's, 80's), with the difference here being that for most of them this was unplanned, and most were not even familiar with the concept of a soundwalk anyway. It can be encouraging then that such sonic augmentation of natural environments could also have an educational value to be explored. Following these observations, our aim is to also implement the concepts described in this paper in more locally constrained performances, where a closer interaction between the elements involved is incident, more akin to a concert in musical terms, where participants' cultural expectations suggest a more focused approach and sound is organized in a constrained space and time.

The proposed work hopefully represents an innovative exploration of the intersection between electronic music, digital interactive system technology, and acoustic ecology. It offers the potential to pave a way towards redefining the traditional concert space as an ecosystemic unit, where the audience, the natural world, and sound composition are engaged in a complex and dynamic dialogue.

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Exploring the Impact of Magnetic Storms on Earth's Ecosystem through Data Sonification

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Abstract

Magnetic storms are phenomena caused by solar activity that can affect Earth. This paper explores sonification as a tool to raise public awareness about how cosmic phenomena such as magnetic storms can impact Earth and human lives.

We first highlight the connections between sonification and Acoustic Ecology. Then, we identify the potential impacts of magnetic storms on the ecosystem. Finally, we present two sonification projects that, beyond numerical representation, attempt to include aspects such as danger, promoting the idea that we are not isolated from the natural world surrounding us. Both sonification projects utilize innovative techniques such as random choices, micropolyphony and probability distributions that can be proven beneficial for efficient and holistically complete sonification.

Keywords

Sonification, Magnetic Storms, Acoustic Ecology, Sonification in Astrophysics

1. Introduction

The soundscape concept has been central to Acoustic Ecology for over fifty years. It aims to deepen our understanding of both natural and human-made environments. Soundscapes highlight the relationship between humans and their auditory surroundings, fostering environmental health awareness. According to Westerkamp (2002), a soundscape composition should encourage a deeper understanding of one's own and other cultures.

Sonification—the use of nonverbal sounds to convey information—also serves as an effective tool for public awareness, with applications in crucial issues such as climate change, demonstrated by over 32 recent projects (Lindborg, Lenzi & Chen, 2023). This aligns with the goals of Acoustic Ecology, aiming to engage the public on critical issues.

Poli (2012) further identifies similarities between soundscape and sonification, noting the designer's intent to convey information and the subjective nuances involved. He introduces the term *geosonification* to describe sonifications derived from natural phenomena, extending the soundscape concept to realms beyond human perception.

This paper first explores the literature linking sonification with Acoustic Ecology. We then focus on the sonification of magnetic storms—significant geomagnetic events that release substantial energy into the inner magnetosphere—and their implications for Acoustic Ecology. Finally, we present two sonification projects that utilize magnetic storm data to offer new perspectives on environmental soundscapes. These projects move beyond simple numerical representation, incorporating qualitative elements of the storms to deepen listeners' understanding of the phenomenon and highlight how cosmic events can impact life on our planet.

2. Sonification and Acoustic Ecology

Sonification in Acoustic Ecology can be grouped into three main categories. The first category centers on promoting environmental awareness. The second combines elements of soundscape composition with

sonification techniques. The third extends into rendering previously inaudible sounds from the natural or technical world within the human auditory range. These categories often overlap, allowing projects to belong to more than one.

2.1. Sonification and ecological systems

Leah Barclay (2019) highlights the importance of engaging local and global communities to listen to environmental sounds, emphasizing how Acoustic Ecology can inspire such engagement. While climate change remains a prominent link between sonification and Acoustic Ecology, additional applications deepen the connection between these fields. Examples include the sonification of agricultural transformation in central Spain (Angeler, Alvarez-Cobelas & Sánchez-Carrillo, 2018), Cheng’s (2022) biodata sonification project, the degradation of Portuguese forests over time (Luzia, 2022) and projects like Patitucci’s and Tyson’s PlantWave (Knight, 2023). Lindborg, Lenzi and Chen (2023) also document 32 climate change-related sonification projects.

According to these authors, the main objectives of these projects are to raise public awareness of critical ecological issues, such as climate change and water resource depletion, and to represent the interaction between genetic mechanisms and ecological environments.

2.2. Soundscape and sonification combination

Recent studies highlight two primary approaches to integrating recorded sounds with data representation. The first approach uses data to create or control a soundscape; Wolf, Gliner and Frederick (2015) illustrate this with three examples leading up to their end-user system. In contrast, Pigrem and Barthet (2017) explore sonification as a narrative tool within a soundscape. Their experiment demonstrated that sonification can effectively convey additional narrative layers within soundscape composition, enhancing communication through auditory means.

2.3. Sonification of inaudible world

Poli (2012) defines *geosonification* as the process of rendering inaudible environmental phenomena audible, drawing parallels with soundscapes in an imperceptible world. He refers to the work of Christina Kubisch, whose soundwalk-inspired projects explore the electromagnetic spectrum, establishing a strong link between sonification and soundscape. Kubisch’s work highlights how much inaudible material surrounds us while both audification and sonification have proven to be valuable tools for exploring these hidden layers of reality. Our environment is rich with signals beyond human perception—from the ground to the atmosphere and into outer space.

Beyond electromagnetic energy, sonification of the inaudible world includes phenomena like celestial objects such as black holes (Knight, 2023) and pulsars (Ballora, 2014), biological signals from plants (Knight, 2023), biodata (Cheng, 2022) and solar phenomena such as solar wind, magnetic storms and substorms (Ballora, 2014). These sonifications aim to broaden public understanding of our natural world, reveal hidden relationships and raise awareness of how distant or unseen phenomena can impact Earth and human and non-human life.

This paper explores the connections between the sonification of magnetic storms and their potential impact on Earth by reviewing relevant literature and presenting two sonification projects that illustrate these phenomena’s potential dangers to increase public awareness.

3. Sonification of magnetic storms

As mentioned above, magnetic storms release large amounts of energy into the inner magnetosphere, disrupting telecommunications and electric power supplies. In extreme cases, the economic loss from a very intense storm in the United States alone has been estimated to reach billions of dollars (Oughton et al., 2017). The impact of magnetic storms on Earth and near-Earth technology is the most direct way these events affect our lives. Viewed through the lens of Acoustic Ecology, such a severe phenomenon could also significantly alter the acoustic environment. Moreover, recent research has uncovered additional correlations between magnetic storms and their ecosystem effects.

3.1. Magnetic storms and Ecosystem

The relevant literature highlights two main categories of magnetic storm effects on ecosystems: biological effects and migratory activity.

The first category, biological effects, includes fluctuations in the Earth's magnetic field during storms that can influence human and animal biology as well as plant growth. For instance, studies have observed correlations between magnetic storms and heart rate variability (Alabdulgader et al., 2018; Papailiou et al., 2023), which is considered one of the most notable biological effects. Other observed impacts include changes in brain function, blood flow, and circadian rhythms, as referred to in Sarimov, Serov, and Gudkov (2023), who provide a comprehensive review of research on the biological effects of magnetic storms and ELF magnetic fields, while Krylov et al. (2014) focus on plants and animals. Krylov et al. (2014) note that much of this research relies on observational data since replicating geomagnetic storm conditions experimentally has proven challenging.

The second category, migratory activity, examines how magnetic storms may affect animal navigation. Bianco et al. (2019) investigated this by studying nocturnal bird migration and found that one of the three species examined showed significant effects during magnetic storms. In a broader approach, Gulson-Castillo et al. (2023) used long-term datasets from Doppler radar and magnetometers, finding that fewer birds migrate during strong geomagnetic disturbances, with a 9–17% migration reduction during severe events. Birds may also experience more significant navigation difficulties during these disturbances, especially under overcast skies in autumn.

Although much of this research is in the early stages and experimental limitations exist (Krylov et al., 2014), these studies suggest that magnetic storms correlate with various ecological effects. Data sonification, independently or combined with soundscape composition or bio-music, could be useful for illustrating these relationships and raising public awareness of how cosmic phenomena impact life on Earth.

The following projects were conducted in collaboration with astrophysicist Fiori-Anastasia Metallinou. Beyond representing the data numerically, these projects aim to convey the qualitative aspects and potential dangers of magnetic storms, emphasizing the connection between cosmic phenomena and their impact on Earth.

3.2. Sonification of magnetic storms projects

Solar activity and its effects on Earth are among the most promising sources for astronomical data-driven sonification. Various sonification projects have represented phenomena related to the Sun, interplanetary fields and Earth, including applications, musical compositions and exploratory tools that depict aspects such as solar structure, radiation, sunspots, solar wind, northern lights and magnetic storms from 1970 to the present.

A summary of these projects (Georgiou et al., 2024) highlights common elements that align with findings by Zanella et al. (2022) on sonification in space science and psychoacoustic experiments (Ferguson & Brewster, 2018, Lăpușteanu A. et al., 2024). Key observations include:

- A correlation exists between the phenomenon's physical properties and musical features when feasible. For example, physical density may be represented by the density of grains in granular synthesis.
- Typically, multiple musical features represent a single phenomenon, which, according to psychoacoustics, enhances information conveyance.
- Sound designers often aim to connect listeners to phenomena outside their senses by pairing sound with visuals that evoke similar qualities. For instance, solar wind is represented by wind-like sounds and particles are depicted through grain-like textures. Additionally, the eerie quality of these phenomena is often captured using textural sounds, reinforcing the listener's connection to the phenomenon, as supported by experimental findings.
- Pleasant sound improves sonification efficiency by enhancing the listener's connection.

We designed two sonification projects at Max/MSP based on the above insights. The first is an electroacoustic composition that integrates the sonification of magnetic storms and substorms with electronic and concrete sounds, creating a rich auditory experience. The second project approaches the phenomenon more informatively, employing micropolyphony and stochastic techniques to represent the quantitative and qualitative aspects of the magnetic storms. This project aims to evoke the essence of these phenomena while allowing for a more fluid and dynamic listening experience.

3.2.1. Solar Strike 8.72

Solar Strike 8.72 is a musical composition that sonifies magnetic storms and substorms using the Dst (Disturbance Storm Time) and AE (Auroral Electrojet) indices as its core structural elements, representing geomagnetic disturbances. The Dst index measures hourly fluctuations in the Earth's magnetic field near the equator, while the AE index quantifies magnetic activity in the auroral zone due to intensified ionospheric currents. Data for both indices were sourced from the World Data Center for Geomagnetism in Kyoto, focusing on the notable August 1972 events, as reflected in the title. Figure 1 provides a graphical representation of data.

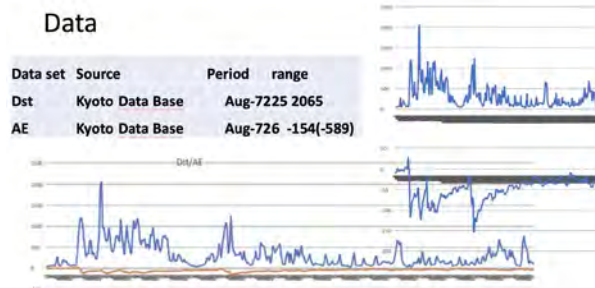


Figure 4

In this piece, we assign multiple acoustic features to express the data from each index. Pitch and intensity are the primary indicators, while additional mappings enhance perceptual clarity and thematic impact. For the Dst index, tempo is mapped to the data, accelerating with increasing values to symbolize the build-up of geomagnetic disturbance. For the AE index, sound density—achieved by activating granular synthesis above specific AE thresholds—metaphorically represents particle density during heightened auroral activity. To further articulate the AE data, the composition alternates between continuous and discrete sounds, accentuating periods of intensity and calm. Discrete, bell-like tones symbolize the auroras, and the overall sound design seeks to evoke a storm's image in the listener's mind, drawing a sonic parallel to the powerful dynamics of magnetic disturbances.

The Dst values are scaled (0 to 154 mapped to 0 to 200) and then linked to the composition's fundamental frequency within an FM synthesis framework, starting from a reference frequency of 660 Hz. Due to their negative polarity, Dst values are subtracted from this reference, creating a frequency range that reflects geomagnetic fluctuations. Scaled Dst values also influence tempo, set between 518 and 1018 milliseconds per beat, while intensity manipulation follows a more complex pattern shaped by layered sound design and aesthetic oscillations. For the AE index, we apply similar mappings but with key distinctions: scaled AE values are added to a reference frequency of 880 Hz to reflect the index's positive polarity. Granular synthesis activation occurs at AE thresholds of 300, 900 and 1200, adding textural complexity and emphasizing shifts in the auroral electrojet's intensity.

The composition is structured into three parts, each serving a distinct purpose. In the first part, only the sonification and temporal progression are presented. This minimal approach allows listeners to connect directly with the data-driven sounds and emphasizes the link between sound and the time series data. This structure is also practical, as the most significant geomagnetic events in the data series occur early on. The second part introduces additional sound material representing magnetic storm impacts. Distorted sounds from a TV broadcast, ATM transactions and Morse code signals evoke the technological disruptions associated with magnetic storms. Using time-stretching techniques to create a layered and immersive auditory experience, these sounds are integrated with the sonification texture. Figure 2 summarizes this part.

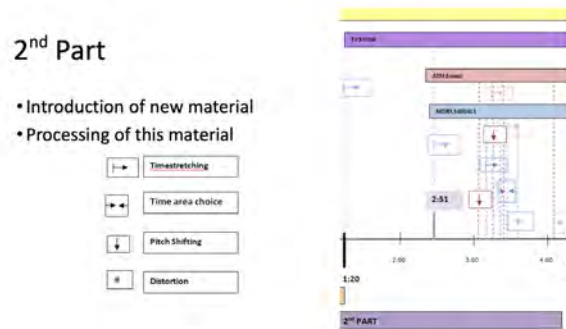


Figure 5

In the third and final part, sounds from both technological and natural sources are incorporated, symbolizing a transition from human-made environments to natural ones. This progression underscores the concept of magnetic storms as cosmic events with technological and environmental implications, guiding the listener from a constructed soundscape to one rooted in nature.

The composition employs FM synthesis techniques to produce varied harmonic content, with fundamental frequencies driven by real-time data values. To enhance fluidity and evoke the organic dynamics of a storm, random variations are applied selectively to less critical points in the sound, creating a sense of spontaneity while preserving the data-driven structure. Each FM synthesis line also includes slight intensity oscillations, representing small fluctuations and adding depth to the evolving soundscape. Through these methods, *Solar Strike 8.72* offers listeners an immersive sonic experience that mirrors the powerful and unpredictable nature of magnetic disturbances.

Audio Visual work is available at the following link:

<https://drive.google.com/file/d/1l8yAyXlbtPtsMzCoOEjoBoDQPsazbF4y/view?usp=sharing>

3.2.2. Stochastic techniques as a tool for the sonification of magnetic storms

Solar Strike 8.72 faces a notable limitation due to its reliance on the Dst and AE indices. The Dst index, retaining its negative polarity, cannot fully capture the magnitude of phenomena at extreme storm intensities. We developed a second approach to sonifying magnetic storms across the full range of recorded Dst values to address this challenge. For that reason, we chose five different periods provided in Figure 2, based on the intensity of the storms, including calm space weather days and the event with the lowest recorded value.



Figure 6

Only the Dst index is used in this second approach, with its polarity reversed. By inverting the Dst values, the sonification reflects storm intensity rather than the index's natural decline. This reversal allows for a direct and amplified representation of magnetic disturbances, focusing on geomagnetic storms' raw power and impact rather than following a melodic trajectory inherent to the Dst index.

We employed a two-layer approach to sonify elements such as danger, turbulence and disturbance—immersing the listener in the experience of an imaginary storm. The first layer conveys the Dst index's symmetrical, horizontally oriented melodic line, providing a structured auditory representation of storm intensity fluctuations.

The second layer, meanwhile, forms an acoustic backdrop that addresses the qualitative aspects of the phenomenon, focusing on the visceral and atmospheric dimensions of magnetic storms.

This dual-layer design allows the sonification to illustrate the numerical data and evoke the sensory essence of geomagnetic disturbances. The melodic line of the Dst index anchors the composition with a clear data-driven progression. At the same time, the background layer adds texture, enhancing the listener’s emotional connection to the concept of a storm.

The micropolyphonic canon, marked by short delays between voice entries, creates a dense, layered texture that reflects the dynamic fluctuations of a magnetic storm. Probability distributions control each voice's rhythm and melodic range, ensuring that the canon responds flexibly to the data. Using 9 sound samples arranged by increasing complexity allows the sonification to mirror the turbulence intensity, with higher disturbance levels activating more complex sounds. Rhythmic acceleration and pitch range shifts add further tension, reflecting the escalating nature of a storm.

The second layer incorporates consonance and dissonance—a less conventional approach in sonification mapping—to enhance the perception of turbulence and evoke the dangers associated with magnetic storms. This method enriches the sonic landscape, adding emotional depth to the sonification by creating an unsettling, unstable sound environment. Dissonance symbolizes disturbance and danger, evoking a visceral reaction that mirrors the storm’s potential effects. According to psychoacoustic research (Ferguson & Brewster, 2018; Lăpușteanu et al., 2024), dissonance is as effective as pitch in conveying negative or threatening sensations. By linking turbulence with dissonance, this layer emphasizes the potential risks of magnetic storms on Earth.

Pitch intensity mapping was chosen for the first layer to represent the Dst index's numerical values. The Dst index values are extended across a melodic range of 3600 cents, or three octaves, allowing even minor fluctuations to be audible. Unlike direct mappings, the second layer is divided into 'zones,' which categorize storm intensity levels for enhanced perception.

Two primary zones differentiate intense storms (Dst values < -100 nT) from less intense ones, with each primary zone further divided into subzones. These subzones align with the intensity thresholds listed in Table 1 for minor and moderate storms. For intense storms, the subzone range is set at 50 nT increments.

Storms' Intensity Thresholds	
Storm's Intensity	Dst Value (nT)
<i>Small</i>	-30 nT
<i>Moderate</i>	-50 nT
<i>Intense</i>	-100 nT

Table 2

These zones affect the rhythmic and melodic parameters, adjusting the central values and range according to storm intensity. More intense storms result in lower central values and broader melodic ranges, underscoring the phenomenon’s severity through rhythmic density and tonal depth.

The main voice is duplicated to further enhance the representation of storm intensity, forming harmonic intervals that shift gradually between major thirds (3M) and minor seconds (2m) to reflect the varying storm thresholds. For intense storms with Dst values below -100 nT, an additional voice is added every 100 units change at a minor second interval, producing harmonic clusters that increase the overall sound density.

Sonifications are available at the following link:

<https://drive.google.com/drive/folders/1VA3Q0xPir99CHHgIKiYme3Fo2AKIVd7A?usp=sharing>

4. Conclusion

Sonification of magnetic storms presents many correlations and opportunities for the Acoustic Ecology field, significantly increasing public awareness about how cosmic phenomena can affect life on Earth. This concept is crucial for the way society addresses science and scientific knowledge. Understanding how the natural world works and its relationship with us is the only way for evolution and progress.

Moreover, we present two sonification projects that, through different choices, attempt to identify aspects of magnetic storms beyond a simple numerical representation. Besides a pleasant sound result and efficient information conveyance, these choices aim to deal with qualities that connect listeners with the potential dangers of storms. The innovative nature of many of those choices, such as using micropolyphony in combination with stochastic techniques, can be proven beneficial in producing efficient sonifications that holistically represent a phenomenon.

Further work includes evaluating the choices to identify what the listener perceives. We intend to add an educational aspect, attempting to find a way to use the sonification of magnetic storms in the context of secondary education.

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A watercolor illustration of a dark bird perched on a branch. The bird is dark, possibly black or dark brown, with a white patch around its eye. It is perched on a light-colored, textured branch. The background is a soft, light-colored wash with some darker, textured areas suggesting foliage or a natural environment. The text "Improvisation, body, voice and space and Acoustic Ecology" is overlaid in the center of the image.

Improvisation, body, voice and space and Acoustic Ecology

Listening Together Across Distances

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Abstract

This paper shares the praxis and the thinking behind our methodology of listening across distance. We consider the electromagnetic spectrum as one of the many layers that compose the natural and human soundscape. We use radio-listening as a way to reflect together on the situatedness and the material and cultural ecologies at stake in every listening, as well as how we understand what listening is and can be, within a collective feminist practice that includes composing, performing, creating installations, living labs and workshops.

Keywords

DIY radio, collective feminist practice, electromagnetic spectrum, natural soundscape, human soundscape, reusable material

1. Introduction

Shortwave Collective draws from a feminist perspective to learn about sound technology together with others as equal non-experts, bypassing the often hierarchical culture and gendered learning experienced in Amateur Radio and Tech clubs. As an international collective we spend time together in each other's company remotely and in hybrid forms—making, testing and sharing DIY open wave-receivers, antennas and other pieces of radio related technologies, often by reusing various components from found and everyday objects and materials.

Our distributed group practice reveals different modes of listening to the electromagnetic transmissions embedded within a soundscape. These radiowaves call for an open form of engagement with their complex, multifaceted, simultaneous and varied nature (Hewitt, 2012, p. 668). These electromagnetic frequencies often draw attention to the position of each listener within a wider constellation of bodies, positionalities, skills, acoustic environments, and technologies. We've discovered that material innovation, time of day, group dynamics, location, reception and other factors contribute to the outcomes. These are unique to the time and place of each listening and each soundscape.

As a group, we combine these individual and topical experiences into a collective network of listenings which are expressed through performances, installations, recorded works and compositions as well as in educational activities such as workshops, presentations and commissions. These processes are necessary for listening to the environmental transmissions that surround us in an open and accessible way to all (Joseph-Hunter, Duff and Papadomanolaki, 2011, p. xiii).

2. Radio is Nature

[Audio clip 1]⁸

Radio is everywhere, it isn't asking to be heard. Radio waves are timeless, organic, physical. They travel through our bodies, they fill the universe.

(Shortwave collective, 2024)

⁸ The Audio clips in this paper are recordings of excerpts from a poem written by Shortwave Collective, read by members of the collective.

Radio is not a sound or a station - it's a range of frequencies on the electromagnetic spectrum. Radio waves are natural phenomena, harnessed by humans. We did not 'invent' them, or 'discover' them (Kahn, 2013, p. 1). They are more often bursts of energy emitted by solar storms and lightning, than controlled transmissions from radio towers. Natural radio can be heard through very low frequency receivers. The air is full with tweaks, whistlers and 'sferics', which may have travelled to you from thousands of miles away, bouncing off the ionosphere to traverse the Earth's curvature.

Radio waves form a complex meshwork of inaudible nomadic "vocalisations" emerging from within the natural world, following on from and enriching existing established understandings on the sounds of the natural world, most notably its stratification on anthropophony, geophony and biophony (Krause, 2015, pp. 11-12). These natural utterances do not exist as passive components of the natural world but exist as energies that are generated from and are responsive to the Earth's movement, environment and climate.

Radio waves can be carrier waves - audio, images and other data can hitch a ride and travel with them across the globe. Their usefulness for wireless human communications has turned them into prime 'real estate'. The entire spectrum has been co-opted, partitioned and sold. Indigenous communities have had to fight for spectrum space, whilst Sámi peoples against the constant expansion of their infrastructure across indigenous territories - contaminating the (sonic) aurora with an ever-encroaching 50Hz hum. In her workshop for Wave Farm, Celeste Oram proclaims 'Citizens of Spectrum, Assemble!' (Oram, 2024): though waves are infinite, frequencies are finite, and this natural resource must be shared.

Our work aspires to reverse engineer the compartmentalisation of the electromagnetic spectrum by highlighting that radio(-listening) can be plural, continuous and fluctuating (Frizz, 2018). The nature of Radio is a network of interpenetrating and overlapping signals that are picked-up across various devices, bodies and environments. Each moment of reception is equally potent or frail. We imagine that the devices and processes we develop to listen to, within and with others "function as unwitting interfaces between the abstract space of electromagnetism and the material cultures of everyday life" (Dunne, 2005, p.111).

3. Feminist Approaches

[Audio clip 2]

Radio-making is always collective. It involves doing, undoing, redoing, trial and error.

Experimentation and failure are integral to the process. Radio is everywhere, and we can listen to it broadly all at once, not just frequency by frequency. Radio is relation.

(Shortwave collective, 2024)

Shortwave Collective (Shortwave Collective, 2021) is an international group of creative practitioners from various backgrounds and disciplines brought together by an interest in feminist practices and the radio spectrum. As a collective, we have a desire to learn together and to open a space to learn together-with-others as equal non-experts. We spend time in each other's company making, testing, listening and sharing; sometimes 'failing', but more often laughing our way into serendipitous results that lead us to new practices and new situated ways of listening. We break-down anticipations of the collective as a shared zone of certainties and preconceptions and build a terrain of collective efforts based on trial, error and mis-hearings and how these register on the "skin" of our individual understandings (Ahmed, 2004).

The collective began as an online discussion and reading group, from our homes dotted around the world. We connected through a desire to escape those didactic and prosaic climates of sound, tech and radio that we'd each experienced previously. When our collective meets, our faces and voices are transmitted to each other via wifi signals. They become data loaded onto radio waves that can travel vast distances. Our individual selves become collectively enmeshed in the electromagnetic commons.

Our approach aims to create an open, inclusive and collaborative, DIY tech-based learning environment, which acknowledges and attends to gendered education gaps and purposefully removes hurdles, such as opaque components lists and assumed knowledge. Part of our ethos is 'learning through doing': practice, sharing knowledge and curious exploration, as well as failure, help us to demystify aspects of technology. We work at distance, across time zones, between or alongside our other commitments, connected through digital conversations and online meetings that often take place during the unsociable hours when our paths can align. At events like this one today, only one of us is present, but the whole collective has been part of the work that we are sharing and the sounds we're transmitting.

4. Radio with others

[Audio clip 3]

We can make radios that receive plural signals and resist the clear channel. We can make radios that resist, and radios that do not receive or transmit signal, yet are not broken. Our hands can be the antennas to the intangible electromagnetic waves.

(Shortwave collective, 2024)

We are (currently) a collective that listens, rather than broadcasts. We listen through different types of radios. Our focus is primarily on a radio of our own design: the Open Wave-Receiver (Image 1). In many ways, this project has trialled our creative and feminist approaches. This radio is open, it's not fixed. Its circuit is open for experimentation.

We've replaced traditional radio components with re-used everyday materials (Shortwave Collective, 2022). We often use tent pegs and other household and everyday objects as diodes. We've experimented with using fences as giant antennas. An Open Wave-Receiver can be taken apart - it is not housed within an impermeable black box. It is meant to be disconnected, reconfigured with alternative objects, locations, and our own bodies. This radio is also open to waves of many frequencies; it cannot be tuned to a singular station, it listens all-at-once to the undulating and layered electromagnetic world that is all around us. It relays radio signals that wave in and out of strength, direction and audibility.

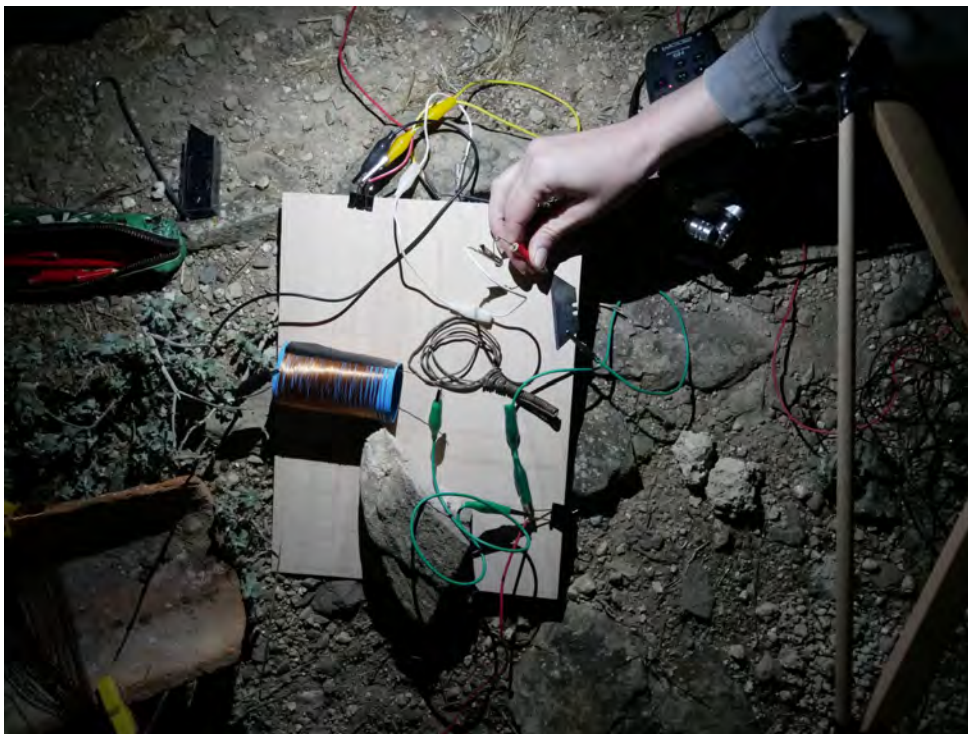


Image 1. An example of an Open Wave-Receiver

Our radio-making workshops are spaces of exchange, and it's important to us that the participants are seen as collaborators; we learn from them as they learn from us, and collectively we arrive at discoveries that we wouldn't necessarily access as individuals.

Co-learning and non-expert instruction are fundamental to our practice, and our workshops momentarily expand the Collective's bubble to welcome in new investigators. We learn rapidly through these workshops - a testing ground of many minds and bodies, exploring the listening capabilities of lampposts, antennas attached to kites, coils wrapped around toys, speculums and rocks, ideas and objects that are woven into our radios by our workshop collaborators. These sessions are our process-based practice taking place. They mirror how we think together as a group.

We align with an understanding that “[radio] is an expansive idea, [demystified] and [innovated] through a do-it-yourself, hands-on relationship” (Joseph-Hunter, Duff, Papadomanolaki, 2011, p. xi) with the sources, materials, environments we engage with, always figuring out, testing and empowering ideas with others.

5. Receiving Radio

[Audio clip 4]

The signals and messages that we perceive within radio are dependent on our position, the weather, a state of material being and a state of mind. Radio is nowhere, until it can be heard.

(Shortwave collective, 2024)

We listen through our various radio devices, at all hours of the day, in different locations and as the seasons change. Sometimes, we make ourselves audible by describing our means of access, the weather affecting transmission, what we heard or thought we heard, our feelings, bodies and positions on the globe. We call these - ‘constellations of listening’ (Shortwave Collective, 2022): the situated, subjective, and site-specific circumstances that align for each unique moment of radio-listening to take place. When you hear singing wafting in and out of intensity on the radio waves, through your antenna in the trees above you, a singular radio station at a constant volume feels laboured and constructed - a facade of fixity in which radio usually operates.

We celebrate the fragility of what is heard, the intricate buzzes and clicks alongside the voices and music, reception as determined by the atmospheric conditions of the moment or the sound of nothing at all when things do not work or there is nothing that we can hear. It is a plurality of possibilities that we listen to, rather than an illusion of singularity where there is one way of being and one body.

The singular listening body is also represented in the aims of radio amateurs and commercial radio services where the signal must be clear and strong or in audio systems of decibel measurement, where this numeric value represents how just one person hears - the Western adult male body. Instead of reinforcing these structures, we use our radio technologies to listen to and through a plurality - of our collective, our collaborators, the materials, environments, time and spaces that we are all connected with.

These Open Wave-Receivers operate on low- to no-power, they are infused with energy contained within the radio waves themselves. It is a system of low power that we amplify with our collective practice - a feminist listening with technology, where ideas of seeming frailty or power are understood differently.

6. Remaining Open

Our listening(s), always plural, always collective, topical and remote, form a network co-located and interdependent sounds (Freed and Rowland, 2013) from within the environment and with and beyond the contributions of many bodies, actions, choice of objects and individual innovations and designs. These direct actions are aligned with an effort to make media and communication systems and technologies open and accessible to communities (Joseph-Hunter, Duff and Papadomanolaki, 2011). Our device(s) work against impenetrable black boxes and aspire to build from the bottom up new understandings of making, designing and listening together that work as an antidote to “expertise”, “mastery” and “control”. Our devices cannot be fully controlled and, in that sense, they are bound to failure, faultiness and malfunctioning. They are fragile, reactive and open to all that is “out there”. These devices, like the electromagnetic spectrum “cannot be commodified... [they offer] us a way through, and a way to break the systems that try to keep us passive” (Rowland, 2024, p.287).

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All That Is Solid Decays Into Air – resonant gestures for ambiances creation

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Abstract

The study is centered on the abandoned building of the Sanatorium in Pilio in Greece, where participants engage in sonic encounters to enhance their understanding of environmental sounds and their implications. Sound is used to uncover the connections between our surroundings and our sensory perceptions. Nature and the built environment have been coexisting for many years and the presence of an infinity of sounds constitutes an ideal terrain for rethinking our aesthetic relationships with our environment. By using tools like Sympathy radio and in-situ improvisation, participants create a dynamic sound "milieu" that fosters a deeper connection with their environment. This approach challenges traditional notions of soundscape (against soundscape) and emphasizes experiential emerging (against immersion) to develop a new aesthetic (sympathy) leading to an engagement with the ambiance of the ruins.

Keywords

Sounds, ruins, sympathy, vulnerability of listening, ambiance, in-situ improvisation

1. Introduction

This work is inspired by the recent floods and wildfires that swept through the Thessaly region in 2023. In response, we chose to focus on the abandoned Sanatorium of Volos, a place where nature and history intertwine. Here, the sounds of the forest, flowing rivers, and growing greenery harmonize with the quiet echoes of the abandoned structure, creating a unique balance. Through resonant gestures, we aim to learn from this environment, expressing a deep sympathy for the place. Our work seeks to forge a meaningful connection, blending the voices of both nature and architecture in a shared story of resilience.

Resonant gestures it is discovering ways of opening our sensitivity to the different natural and artificial phenomena, and to explore the smooth transformation of the impoverishment of our sound environment. Resounding of abandoned place is a methodological tool - the sound as universal language - for understanding the links that emerge between sound, space, and body in different entanglements of our built spaces with their environment. The sound immerses the participants (you cannot escape from it) and it expresses in a much stronger way the potentials and vulnerabilities of living beings and things that coexist in the same space.

We consider the vulnerable, abandoned and collapsed contemporary buildings with all the organic processes that take place slowly in time, an ideal context for the research of new mediums of aesthetic co-creation and inclusive cohabitation (beings and things). Usually, creators are concentrated on the visual satisfaction and distant contemplation of such sites (ex. by taking photos), and less on their sensible qualities and on how these can inspire the improvement of our living conditions. The immaterial nature of the sound allows the experimentation and improvisation in such dangerous, hostile and mysterious places, without necessarily taking any risks with their cultural context or their decayed materiality.



Figure 1. Forms of coexistence of nature and building materiality, Sanatorium site, photos by Christos Schoinas (May, 2024)

This research is concentrated on how listening to the organic and material processes in time that moves slowly in contemporary ruins can inspire the ambience improvisation, by engaging the sounds, the space and the body (human and material) in a sonic encounter that will change our listening to our environment in ways that we have never imagined before. For the previous reasons, the research overcomes the scientific questions around the maintenance or the renovation of the ruins, to face more existential questions, and to explore forms of sympathy between the natural and human activities in these shared environments. The main question that arises is: How can listening to the ruins encourage listeners and creators to hear the inner world of other beings and things?

Confronting the difficulties of a ruined site, enables the letting go of an authoritarian knowledge - for in situ creations according to the affordances of the site, for an architecture that leaves the freedom of improvisation of new lifestyles. To feel the immaterial and give sense to the material world we need to understand the correspondences of the sensitive flows that irrigate our daily lives, and which therefore commit us to forms of vulnerability. The medium in which this happens is the atmosphere, affective and environmental, in which we are immersed. We see in it, hear in it, smell in it, touch and move. Therefore, the atmosphere is not what one perceives, it is not an object of perception. It is from what one perceives, what opens the perceptibility of the world and allows perception (Thibaud, 2022).

2. Inclusive listening

Contemporary approaches consider the soundscapes as something which is out there waiting for us to tune in. Tim Ingold in "Against Soundscape" (Ingold, 2007) suggests that listening to soundscape objectifies sound rather than treating it as experiential. For Ingold, sound is an occasion of "our immersion in, and commingling with, the world in which we find ourselves". Consequently, listening to the sounds around us underwrites our capacity to immerse in the ambience of the place with all our senses, and not just by staying still in a place and trying to harmonize with it.

By responding to the affordances of a place, the place itself responds back to us, in ways that can surprise us and put us in sympathy with our surroundings. For Spuybroek, it is by sympathy that architecture can focus its aesthetics on the sensibilization around such dynamic processes. As he says, the beauty of things comes when we can feel the forces that exist between things and forms, and this can only happen in the transparency of the life sustaining medium in which we are immersed and with which we can see, hear, touch, smell, and move (Spuybroek, 2011).

The methodological hypothesis is based on our scientific incapacity to understand the very conditions of the experience we live. We must therefore develop an approach to the site through atmospheres, to open up to our senses the forms in which the atmosphere appears. This work makes the methodological hypothesis that the attentive listening of the back-plan (ex. the wind, the water flow) and the resounding of the sound events activated by the participants (both beings and things), can inspire the improvisation and the ambience creation of places (Thibaud, 2022, Paxinou, 2017).

The ruined site we selected for this research is the abandoned building of the sanatorium for tuberculosis patients in Greece, founded in 1907 by Karamanis, at an altitude of 1200 meters, very close to the settlement of Chania of the mountain Pelio in Greece.



Figure 2. Sanatorium façade and recorder positioned on a room's windowsill
photos by Christos Schoinas and Nicolas Remy (May, 2024)

The first building was a stone two-store old inn, with a wooden roof and ceramic tiles. In 1915, two new two storey wings were added, with a long corridor that serves the patients' rooms, a small chapel and the auxiliary areas, and big transverse wooden openings for natural lighting and ventilation. Inspired by modern architecture, it was built with masonry and reinforced concrete slabs. Its form was perfectly adapted to the natural sloping ground, offering on the roof spacious sunny terraces with great views towards Pagasitikos gulf, where the patients could take advantage of the sun's rays that penetrated the otherwise dense and damp forest. The difficulties from the Second World War and other financial problems later led to its abandonment. Since then, the structures have decayed, the wooden roof and parts of the masonry have collapsed, the floors are covered with soil, the plasters have come off, the windows are broken, and they have become an organic part of the surrounding beech forest, with its sources, its river and the hiking trails. Today, the Sanatorium ruins can only be accessed by foot.



Figure 3. The ruins of the Sanatorium, photos by Christos Schoinas and Petros Flampouris (May, 2024)

So, what really triggers our attention is the research of creative methods of hypersensitivity stimulation in architecture. 92,5FM Sympathy radio (Paxinou and all, 2023) is used to connect body sound and place when the body of the participants cannot be physically where the sound is produced and heard. For obvious reasons of security, it gives the opportunity to hear close to the ruins without being inside. Because of the invisible radio waves, it offers the opportunity to listen to sounds that can't be physiologically heard (ex. they are not loud enough). It's also used to connect sound places that are far away from each other, or to hear remotely a not accessible place - like the ruins - because of the size, the height, the depth of a hidden cavity. To do this, the whole body becomes an extension of the antenna and the microphone, and participates in the action of listening by walking, moving, bending, wandering, running, creating and performing sounds and noises.

Inspired by the above experimentations and the work of Bernhard Leitner in 70's on the creation of sensations by the possible sound configurations and body postures in empty spaces, this research attempts to experiment with the in-situ embodiment of the auditory experience to activate the affective responses of the participants. How can the living/dynamic body come in sympathy with the living/dynamic space in-situ through the immateriality of sounds?

92,5FM Sympathy radio sets combined with wired microphones, and portable small sound systems were used to listen and experiment with the site of Sanatorium. These technical tools are given to the participants without any instructions. They use them, test them by listening to the effect of moving the position of the microphones, the position of the speakers, the positions of the body in action, play with the near and far acoustic field, amplify certain sounds, mask others, manipulate, filter, mix sounds. A performative and dynamic sonic milieu is created and experimented. In situ improvisation makes it possible to reveal with the available material the musicality of the soundscape and the environmental potentials of the space, by allowing the actors to move from a passive listening position to active and creative actions. In another word, participants engage their listening and their actions in different minimal resonant gestures to make the space resound through them.

3. Resonant Gestures

"Resounding ruins performance" involves a change in sound posture on the part of the participants, both in terms of attention to existing sounds but also in terms of the potential consequences of their actions. This commitment unites the participants, the site, living beings and things and does not a priori hierarchize the sound presence of a particular event. How can a sound be heard, felt and what body postures should be adopted to get in sympathy - more than tune in - because we don't want just to be harmonized with certain sounds, but to be "drifted away by the different sound flows that heightens our awareness (filtering, reflections, pitches of sounds). What are the minimal resonant gestures that encompasses a dynamic interplay of bodily responses, deeply rooted in the auditory cues provided by the environment, both constructed and natural?



Figure 4. resonant gesture in Sanatorium, photos by Christos Schoinas (May, 2024)

In music, (resonant) gesture is any movement, either physical (bodily) or mental (imaginary). Resounding ruins with resonant gestures is engaging participants in a process of improvised creation. For the improvisation, several sets of equipment are used in a site in order to invent and perform different resonant gestures in it. There is no musical score or any chief of orchestra to be conducted by. Participants share their resonant gestures with the others and improvise a sound performance. Many sounds are proposed, tested, amplified, manipulated, and the sound space that is revealed is the main link between the participants. The participants are not necessarily in visual contact but share this sound medium which contains the permanent background of the site and all the events which are activated by them. Numerous experiments are made until an atmosphere is established in the performance. There is no musical partition but there are technical limitations - bricolage and DIY techniques – combined with professional equipment. The conditions of the experience are defined by a finite list of means, (Ex. lifetime of the batteries), and by the site itself and its ambient affordances.



Figure 5. Non-standard acoustic measurements in Sanatorium, photos by Evangelia Paxinou (May, 2024)

3.1. Against Soundscape – understanding the back plan

The participants' first action was to select an abandoned windowsill - room in the building and record for as long as the tape recorder's battery life allowed. The duration of the soundtrack is 37 minutes and 9 seconds and witnesses the natural elements of the site, namely the stream which flows nearby, the random chirping of birds, the wind, the breeze in the branches of the trees, the absence of our activity. With the presence of the sound of the river, which is very dominant and masks, it is difficult to hear the more intimate sounds such as those of insects or the smallest movements of nature (the fall of a small stone, the movement of a small animal).

Listening to the recording is not actually that important. What matters is the resonant gesture of pressing the recording, which engages the body to move away from the position of the mic to disappear, to become silent and to withdraw from the site, by opening one's ears and body to vibrational phenomena.

A similar resonant gesture was also the performance of a sound walk with binaural headphones microphones inside the ruins (in places where the participants felt safe), trying to "catch" the sounds of the place. The participants during the sound walk are more concentrated in revealing to their consciousness the sound qualities of the space: the listening body in movement reveals the effects of the materiality of the building (ex. soil on the floor, collapsed walls, broken windows, thick stone walls, depth of silence, diffusion of human sounds) to the natural sources of the back-plan (ex. the sound of the river, the wind flow).

3.2. Against Immersion – Sensing sympathy between events and back plan

The performance continues with a series of experiments aiming to connect the participant's body, the sounds (natural and artificial) and the space. "Against immersion phase" aims to listen and act on the ambiance of the site by performing resonant gestures to unbalance the ordinary relations of the back plan with the sound events, so that participants can create an atmosphere by getting in sympathy with it. You need to get out of a situation that starts to "haunt" you (like the infinite sound of the river) in order to realize how you want to continue being in it. For example, participants select a microphone with different sensibility, with fast or slow response, which they can amplify it, stream it and play it in another place louder and/or filtered.

Or they can try to be in the place of a stone, or a leaf, or a tree, or a brick, by putting the microphones in places where the human ear (body) could not fit or access. If the sound environment is balanced and permanent, what does it mean to hear it from a non-human perspective?



Figure 6. Wired microphones in several positions and ready to be plugged in Sanatorium, photos by Christos Schoinas (May, 2024)

These improbable positions allow the participants to engage in creative listening. In fact, they emit sounds close to the microphone (Ex. rustling of leaves, cracking of small pieces of wood, noise of impact between 2 different materials, rolling of a mixture of sand and gravel, etc.) and the sound system allows all participants to hear it and play on it.



Figure 7. Resonant gestures for resounding ruins, photos by Christos Schoinas (May, 2024)

The position of the listening body is experienced for its effectiveness to bring out the perceiving body from the "natural" atmosphere (against the immersion) for the creation of a perceptible distance (being outside). The challenge is to maintain the perceiving body in a state of perceptual hypersensitivity.



Figure 8. P. Flampouris, E. Paxinou and N. Remy performing resonant gestures in the Sanatorium ruins (April, 2024)

Another resonant gesture is the diffusion in a loop of a pre-recorded contemporary cello piece, with a portable Bluetooth speaker connected to a smartphone, while the participants are trying to select the position of the portable loudspeakers (position, intensity, orientation), to amplify the sounds and to improvise with gestures, responding to the music.



Figure 9. Resonant Gestures for resounding ruins Sanatorium site, photos by Christos Schoinas (May, 2024)

Many sounds are "transduced" (Helmreich, 2010) i.e., recorded, transformed and transmitted. The sounds are mixed up (sound effects) and play the role of sound transducers of one space to another, of a source and its receivers whether they are living beings or objects. Stefan Helmreich refers to "against immersion" for sounds that can be converted into another energy (from sound waves to electricity), transmitted somewhere else, in order to make them audible or sensible again (from electricity to waves), like the Sympathy Radio or the transmission of a music piece played from a mobile sound source (Bluetooth speaker).

Live streaming of these plugged and unplugged sounds is essential in the general process of the listening in order to generate the sympathy between the participants with their resonant gestures. Technology is experimented in situ and is used to engage creative listening. Technical limitations are not explicit at the beginning for the participants. Position of the microphone, of the loudspeakers, length of the cable, sensibility of the mics, associated with several positions of the body are the participant's palette for a free improvisation. It's like learning how to play an instrument. The learning phase is part of the creative process. There is no beginning or end but a time of lived and shared experience.

4. Musicalize the sound environment – ambiance improvisation

We often feel that our sound environment is poorer, quieter. According to Ingold this happens because we are formed to close our ears to sounds that are not in the spectrum of our attention, and they do not manage to arise from their back-plan. For him, this happens because we are used to split music from life - from its background with all its disturbing noises, in order to appreciate the musical composition as an isolated object. We need to participate in the auditory experience, to be able to feel the correspondences of music with its back-plan. And then all these "silent" sounds become "music" to our ears, because we become musicians too. Without our participation this could not happen the same way. Like when we are seated still in the stands of an open-air theatre for a piano recital, and we try to match the rhythm or the melody of the cicadas to the musical composition. We can feel the conflicts among them, and soon we must decide which sounds we want to follow.

All of the human actions and technical systems that are performed in situ near the abandoned ruins of the sanatorium, in the forest of Mount Pelion, create a hybrid environment, a mix of the sound worlds (human, beings, things, and transduced sounds) as a medium of the improvisations. The experience ends when the participants instinctively feel that all the sources are in sympathy or, as Stefan Helmreich says, when natural, lived streamed and transduced sources produce a "sense of effortless presence": All That Is Solid Decays Into

Air (Flampouris and al, 2024) is a sound improvisation performed on the abandoned building of the Sanatorium in Pilio in Greece which is therefore the witness of these moments.

The resulting sympathy sound effect describes this harmonious interaction between the participants, their joy and their satisfaction of experiencing it. In this sense, the effect goes beyond the spectre of the soundscape (inherent distancing of the concept), and it engages all the senses and the body in movement. It imposes an ambient tone on the site in which the dimension of improvisation is fundamental.

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Soundscape Analysis

Non-standard acoustic measurement for architecture soundscape mapping

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Abstract

This paper discusses an ongoing PhD research aimed at developing tools and techniques for studying the sound environment of specific locations. The goal is to integrate these findings into early design stages of architecture and planning. The research seeks to complement traditional acoustic measurements with qualitative criteria suited to particular sites and their unique sound phenomena. The study employs advanced instruments like measuring microphones and sound analysers, as well as DIY tools including custom microphones and sensors. It features a case study of an abandoned building in a rural area, mapping its soundscape through non-standard acoustic techniques, emphasising qualities arising from the environment rather than the building itself. The methodologies span various scales, addressing sound analysis from regional spaces to individual buildings and exploring diverse contexts like urban and rural areas. Expected outcomes include measurable, sound phenomena validated through recordings, which will support improved architectural design strategies and enhance sound environments in created spaces.

Keywords

Architecture, build environment, acoustics, soundscape, ambience, sound phenomena, sound qualities

1. Introduction

A standardised acoustic measurement is a method for evaluating sound and acoustics in a space according to established protocols, like those set by ISO standards. These standards ensure reliability and comparability across different locations and operators. Key acoustic parameters measured can include sound pressure level, reverberation time and speech intelligibility.

In situ measurements face challenges due to variable conditions such as background noise and environmental factors, which can affect the results. Non-standard acoustic measurements adapt techniques uniquely to specific settings (Remy, 2004; Ndrevataj & Flampouris, 2024; Boubezari et.al., 2024; Paxinou et al., 2023). For example, instead of using calibrated white noise, sounds like running water may be employed. This approach seeks to reveal the sonic qualities of various elements in the environment, amplifying the voices of both natural and man-made components.

This study focuses on the abandoned Sanatorium in Pilio (Paxinou et.al., 2023), Greece, exploring its unique soundscape shaped by time and natural events. Following severe flooding in September 2023, a nearby river has altered the acoustic environment, creating new sound dynamics. The deteriorated state of the building—with collapsed roofs and missing windows—renders traditional measurements impractical. This project uses non-standard techniques to capture interactions between nature and architecture, documenting sounds like wind through broken walls and the rush of water. The goal is to reveal how sound informs the relationship between human presence and ongoing environmental transformation.

1.1. Ruin Shell as a place of interest

The site selected for this research is the abandoned building of a sanatorium for tuberculosis patients in Greece, which was founded in 1907. It is located at an altitude of 1,200 meters on Mount Pelion. The building is a two-story stone structure that originally functioned as an inn and features a wooden roof with ceramic tiles. It has two wings with a long corridor that connects the patients' rooms, a small chapel and auxiliary areas. Large wooden openings were incorporated to provide natural lighting and ventilation. Inspired by modern architectural principles, the sanatorium was constructed with masonry and reinforced concrete slabs. Its design was perfectly adapted to the natural slope of the land, offering spacious sunny terraces on the roof that provided great views of the local gulf. This allowed patients to enjoy sunlight, which was especially beneficial in the otherwise dense and damp forest. Unfortunately, due to the difficulties stemming from the Second World War and subsequent political and economic issues, the sanatorium was abandoned. Since then, the structures have deteriorated; the wooden roof and parts of the masonry have collapsed, the floors are covered with soil, the plaster has come off, and the windows are broken. The ruins have become an organic part of the surrounding beech forest, along with its streams, rivers and hiking trails. Today, the remains of the sanatorium can only be accessed on foot.



Figure 1. A distant view from the sanatorium building shell. 1b. See from the kitchen close to the river

1.2. Chained measurements

In a standard acoustic measurement, the process begins by referencing the measurement microphones to a source of white noise. In this case, we used the sound of a flowing river as our reference. A series of recordings were made at various positions (see Figure 2): by the river (position 1), on the ground floor by the old facade (position 2), by a collapsed opening (position 3), in an old kitchen (position 4, 4'), in the corridor (position 5, 5'), on the top floor behind a collapsed wall (position 6, 6'), in the middle of the terrace (position 7, 7'), at the edge of the terrace (position 8, 8') and by a brick wall covered with ivy (position 9). These positions were used to compare the recorded sounds and to analyse the soundscape characteristics of the ruin.

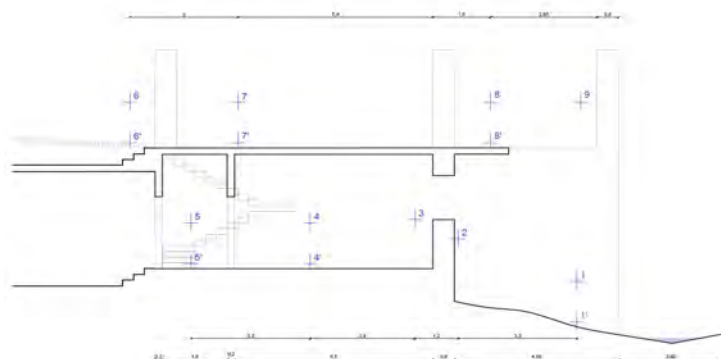


Figure 2. The section presenting the recording positions

1.3. Calibration of the chain of measurement

For the comparative analysis of river sound signals, three types of microphones were used: a 01dB Solo Class 1, a Beyerdynamic MM1 condenser omnidirectional and a Rode M5 cardioid small-diaphragm. Measurements were taken at 1.20 m and 15 cm heights. After calibration at position 1, the Beyerdynamic MM1 and Rode M5 were used for quantitative measurements, recorded in mono WAV format. Stereo recordings were made simultaneously with a Tascam, employing a 16-bit stereo format at a 44.1kHz sampling frequency. The mono WAV files were analysed using 01dB-Acoem's software, dBTrait32, focusing on temporal variations of Leq 1s in dB(A) and one-third octave band frequency changes.

At half a meter from the source, the overall sound level was approximately 72 dB(A), masking participants' voices. The river's current created a dynamic soundscape with rhythmic variations, but it was not relaxing. The average frequency spectra mirrored the microphone characteristics, revealing that the river's signal lacked low frequencies yet was rich in mid-range. The Beyerdynamic MM1 performed better in low frequencies, while the 01dB microphone proved to be unsuitable for non-standard conditions. Moving forward, only the Beyerdynamic MM1 and Rode M5 will be used. Among stereo fragments, the Beyerdynamic MM1 most realistically captured the sound scene, especially the low frequencies.



Figure 2a. From right to left, there is a view of the small river, the position of the microphones for the calibration setup, and the facade of the kitchen of the sanatorium. Sections 2b and 2c zoom in on the microphone setup

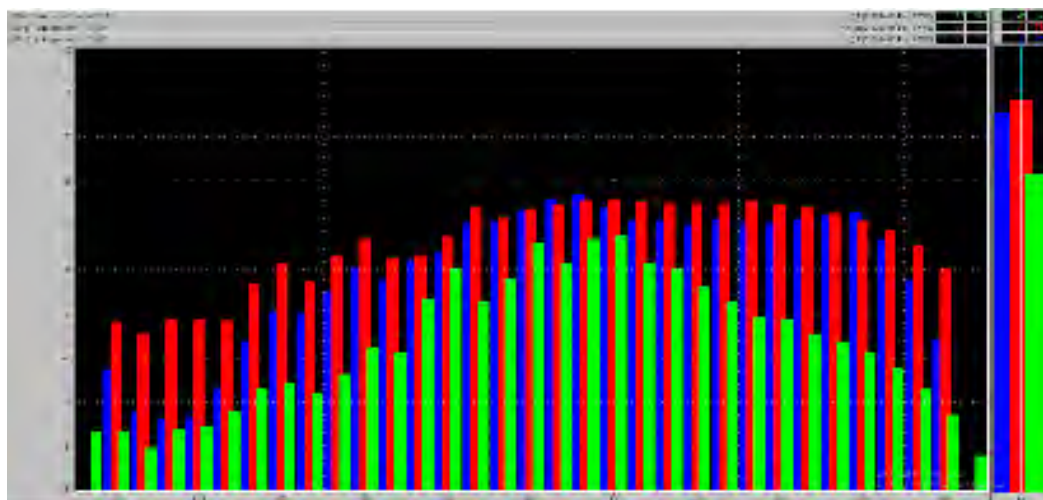


Figure 3. Average spectrum analysis at position 1, along with the average value of Leq in dB(A) for the river noise near the sanatorium. The two microphones, MM1 (red) and MM5 (blue), were positioned at a height of 1.20 meters above the ground, in conjunction with the 01dB Solo (green)

2. Escaping from the white noise

The first series of measurements focused on studying the overwhelming white noise generated by the nearby river, which registered a formidable 72 dB(A) at just half a meter away. This intense noise obscured all frequencies, masking out not only the ambient sounds of the environment but also the voices of the participants involved in the study. The change in measurement positions shows (Figure 4) that from a sound intensity perspective, a significant decrease in the sound level of the river can only be observed when the built environment obstructs the propagation of its sounds. From a frequency perspective, the sound spectra recorded by the two microphones at all measurement points are very similar (Figure 4). This indicates that the built environment and the materials used in the space do not locally alter the river's sound spectrum; in essence, no frequency filtering effect can be measured.

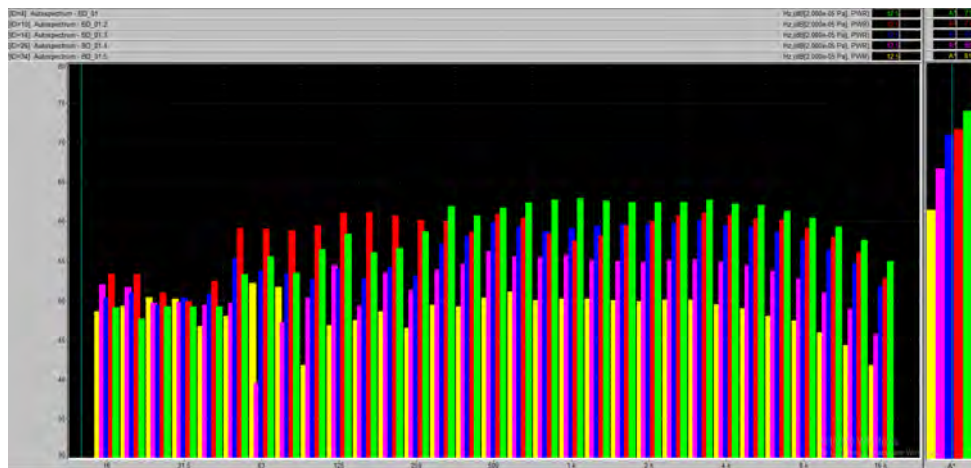


Figure 4. This text compares five measurements taken at ground floor level using the same microphone type (Beyerdynamic MM1), positioned at a height of 1.20 meters. The positions are as follows: Position 1 (green), Position 2 (red), Position 3 (blue), Position 4 (magenta) and Position 5 (yellow). The graph shows that there is approximately a 3 dB (A) drop in every position, with a consistent curve across the entire frequency spectrum. Most positions are located within the building fabric, except for Position 2 (red) which is situated by the facade wall indicates that the reflective surface of the stone masonry is influencing the measurements

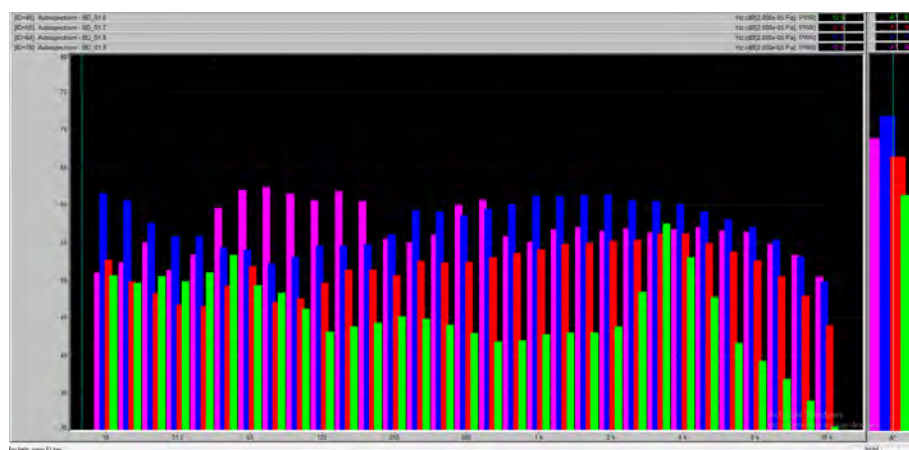


Figure 5. A comparison of all four measurements at the ground floor level. Position 6 (green), position 7 (red), position 8 (blue), position 9 (magenta)



Figure 6. A comparison of all dB(a) at all selected positions, presenting a drop in every position

The sound of the area is proven to be unavoidable in the ruin. The substantial presence of the built environment does not prevent the river's sounds from being heard when the listener—either the microphone or a person—has visual contact with the source. The building integrates nature, and nature is an essential part of the structure. It is only when one is behind a wall (Figure 4, Figure 6, positions 6 & 9), away from the facade, that the sound of the river fades away, allowing other, more delicate sounds to be heard.

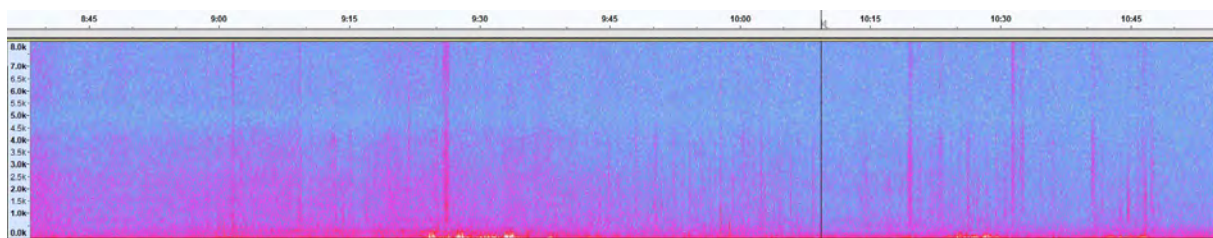


Figure 7. Escaping from noise. Two out of twenty minutes walk through the ruins. Transitioning from room to room, as the ruin envelope is absent, the infiltration of the river's sound signal alters. The river noise is rendered in the spectrogram, visible until 4k for the first minute. The next minute, as we transition to a room with no opening to the river, the noise is absent. In sound science, it is possible to hear the also the hard surface of the wall and cladding. A setup of a Soundman OKM-II binaural microphone with a pre-amplifier (Soundman A3) connected to a Tascam DR-40 recorder, was used. The binaural recording technique was chosen to capture the spatial characteristics of the sound environment, allowing us to locate and position sound sources spatially within the recording

3. To lie on the floor

At each measurement point, the microphone was positioned close to the ground (approximately 15 cm), simulating the perspective of someone lying down with their face close to the earth. This unusual placement allows for a unique acoustic capture, highlighting the close relationship between the sound and the textures of the ground, influenced as well by our body position. The floor inside the building is now covered with soil, making it highly absorbent in terms of reverberation. Meanwhile, the hard concrete terrace is partially covered with moss.

The measurements show a low-frequency reinforcement across all measurements when the microphones are close to the ground (Figure 8). This is a sound filtering effect that reinforces the idea that at ground level, the listening is not experienced only through the air but also through the solid, making it highly sensitive to vibrations

and low frequencies. However, this does not prevent high frequencies from being present in the recordings and during listening (such as the river and birdsong).

By positioning the microphone in this way, the measurements reflect a more intimate and grounded perspective, capturing subtle vibrations and resonances that might otherwise be overlooked. This approach enables the recording to capture the acoustic nuances that arise from direct contact with the earth, providing a perspective that is closely aligned with the materiality of the site itself.

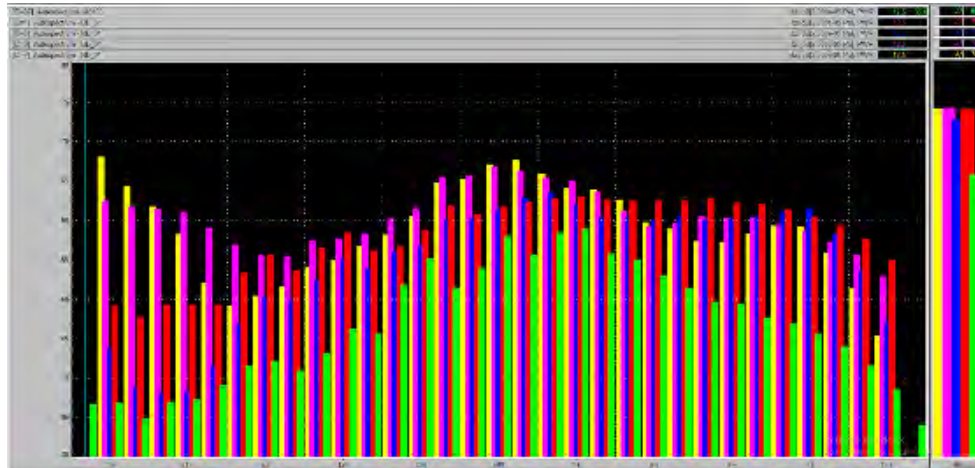


Figure 8. A comparative analysis of the signal sound of the river, comparing the measured signal of 01dB Solo (green) at a height of 1.20m, Beyerdynamic MM1 (red) at 1.20m, and Rode M5 (blue) at 1.20m. Additionally, comparing Beyerdynamic MM1 (magenta) at a height of 0.15m and Rode M5 (yellow) at 0.15m

4. Hear like a little one

As we continued the field study, we found ourselves listening to the river's white noise from a new listening point or even perspective, through a small hole no larger than an insect or cleverly shielded by a protective canopy of leaves. This unique vantage point allowed us to capture the overwhelming sound of the river while also attuning our ears to the subtler and hidden sounds in our surroundings. The leaves acted as a natural filter, reducing the intensity of the river's roar and allowing us to perceive the delicate sounds that are often overlooked. Through this tiny aperture, it could be possible to hear the faint rustle of a small stone and the subtle movements of an insect, blending those intricate sounds with the distant, ever-present hum of the water. This approach deepened our understanding of the in-situ soundscape, highlighting how various auditory elements coexist and interact, even amidst a dominating sound like the river. By immersing ourselves in this microscale experience, we aimed to uncover the delicate balance of life thriving around us, revealing the intricate layers of sound that define our environment. This focused listening transformed our perception, making us realise that even within a cacophony, there are always hidden whispers waiting to be heard.

The measurements show that the frequency spectra are practically flat when recorded in an open field. The recordings are noticeably filtered differently regarding the frequencies (Figure 9), in the crack of the wall, or an ivy tree has an effect (quantitatively) on the sound field around the microphone. Hearing like a “little one” creates a noticeable difference in understanding the surrounding soundscape as soon as one listens through the reference fragments.

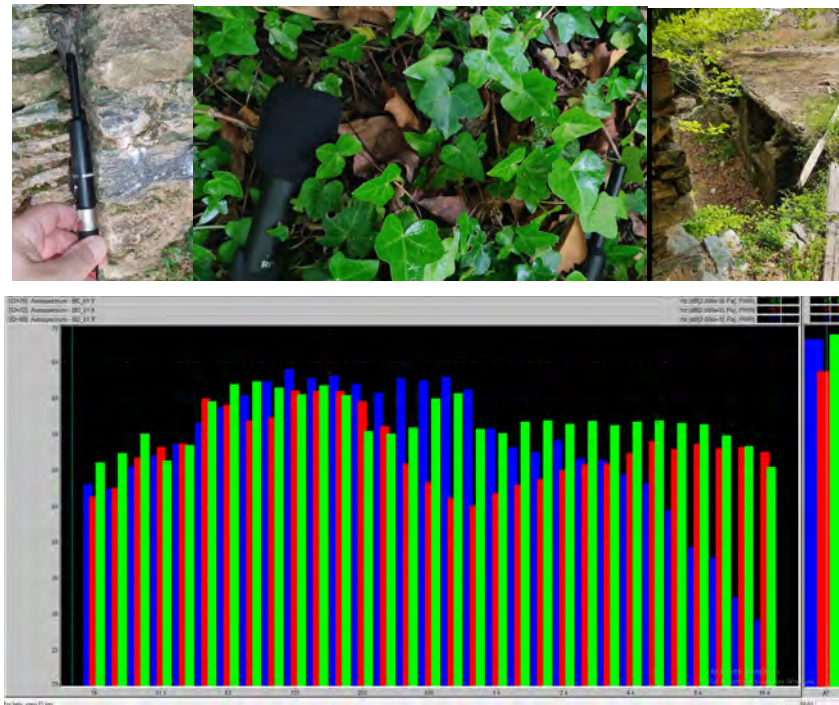


Figure 9. Top, new listening perspective. Bottom, the sound of the river is recorded on the rooftop (green), and the same sound is recorded through the leaves of an ivy tree (red) and from inside a stone wall in the clay mortar (blue)

5. Chapel Flutter echoes

In the context of non-standard acoustic measurements conducted within the ruins of the destroyed chapel (Figure 10), we observed the emergence of flutter echo effects. These effects were not distinct phenomena but rather a reflection of the conditions that allowed them to occur. The chapel's fractured walls and irregular surfaces created a complex interplay of sound reflections, causing short echoes to bounce off uneven surfaces and converge at specific points. Additionally, the highly absorptive nature of the floor contributed to this acoustic environment by dampening certain frequencies while allowing others to resonate. The unique architecture and sound-absorbing flooring of the chapel created conditions suitable for flutter echoes to emerge. This revealed how the layout and material properties of a space can influence its acoustic behaviour (Figure 11). The interaction of sound within the chapel emphasized the need to understand not only the effects of sound but also the specific environmental factors that contribute to these phenomena. This offers valuable insights into the relationship between space and sound.



Figure 10. Non-standard acoustic measurements in Sanatorium, photos by Evangelia Paxinou (May 2024)

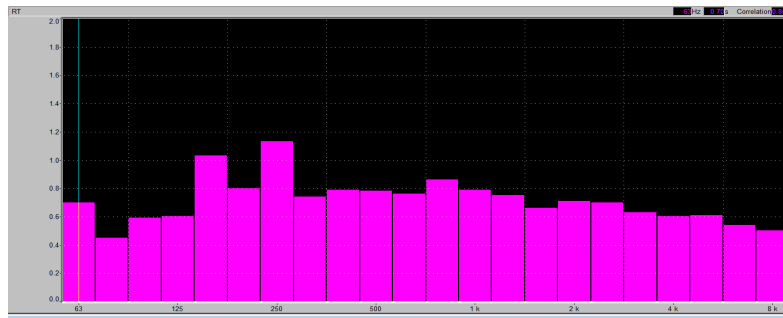


Figure 11. Reverberation time (RT) response in the different frequencies in the chapel room

6. Discussion

We utilised architectural features like walls and overhangs to create a buffer against intrusive noise, effectively reducing the river's roar and enhancing our data collection clarity. By adjusting our position and monitoring sound levels, we explored the interplay between natural and created soundscapes, emphasising the context's importance in our auditory assessments. This exploration laid the foundation for understanding how the built environment shapes our acoustic experience, fostering meaningful dialogue essential for our research (Figure 12).

Our sound measurement methods highlight the relationship between objective data and subjective listening experiences, underscoring the need for both analysis and attentive listening. By capturing these soundscapes, we gain insight into their properties while recognising the emotional responses they evoke.



Figure 12. [The sound collage Spring Water Response composed from fractions of the field recordings, the volume differences are not mastered, in order to present the volume differences from the site](#)

In the case of ruins or unique acoustic environments, standard measurement techniques may not be applicable. Instead, it's suggested to engage with the site through real-time sound phenomena. This approach expands participants' acoustic perception, incorporating even typically silent sounds and transforming the atmosphere. It fosters a deeper connection to the location's history and future.

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The sound territories of diversity, between humans and non-humans An anthropological-biodiversity approach of the soundscapes territorialization in urban resourcing areas

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Abstract

This research is part of the LIFE Biodiver'City and Resilience (BCR) ecological restoration project for residents, whose acoustic dimension refers to the "quiet areas" component of Bordeaux Metropolis's Environmental Noise Prevention Plan (PPBE). It presents a multidimensional landscape indicator; the sound source's presence spectrum, designed to capture the spatial evolution of the bio- and anthropophonic qualities of the living environment within "resourcing" urban territories. This hybrid method, tested on the Bois du Burck in Mérignac (France), is currently being extended to other quiet areas (as defined by the European directive 2002/49/EC) - woods, forests, parks and gardens - in the Bordeaux metropolis. The results concerning the territorial sharing of sound practices between humans and non-humans are sometimes unexpected. Ultimately, this ambient analysis model will evolve into a tool for observing and spatially qualifying these "quiet areas".

Keywords

Anthropophony, Biophony, Resourcing, Quiet Areas, Presence Spectrum, Bird Songs, Bugs stridulations, Territorial Sharing

1. Introduction: anthropization of territories and deafening of natural landscapes

Assessing biodiversity is one of the major challenges in ecology. Thus, the use of sound constitutes one of the most accurate observation techniques for taking wildlife manifestations and human activity into account in urban and peri-urban environments. As birds and bugs are the main sound emitters in nature, they exploit distinct "acoustic niches" throughout an intelligible sound spectrum, even when immersed in anthropo (Krause, 2002) - or even technophonic landscapes (mechanical noise from motorized traffic). Biophony as a natural acoustic space composition should therefore design the species environment by minimizing sonic overlapping effects between the biotope actors. These sound sources play an important role in resourcing experiences in quiet peri-urban areas, making them a major part of the natural landscapes of our cities.

This study aims to test the validity of new bio- and anthropodiversity indices based on an acoustic analysis of the choruses produced by animal and human communities within soundscapes. Their cartographies enable biophonic (birds and bugs in particular) and anthropophonic (human activity) analysis of the city's quiet areas.

1.1. Anthro- and biophonic metropolitan territories analysis through bird song spatialization

The massive anthropization of natural areas greatly impacts animal and plant biodiversity in terms of functional territorialization (reproduction, food chain, etc.). The resulting sound compilation reveals the problems of habitat fragmentation between humans and animals.

Birds' audibility in our cities is a growing indicator of the current decline in urban biodiversity over the last 25 years (Gasc et al., 2017). A study led by scientists from the University of East Anglia⁹, who reconstructed the soundscape of over 200,000 sites over 25 years, points to reproduction and food chain disruption of birds. The study reveals a considerable weakening of birds' acoustic messages, which could damage the already endangered relationship between humans and non-humans.

According to a recent study published in *Nature Communications*¹⁰, climate change is also responsible for the decline of avian populations, by causing an imbalance of the species distribution in various natural habitats (Morrison et al., 2021). The large decrease in the bird population affects the quality of perceptual experiences relating to nature's manifestations. The perception of the presence and diversity of avian fauna is better described by its sound than by its sight. This is why analyses of resident avian populations' sound presence constitutes one of the best ways to evaluate biodiversity.

Thus, birdsong soundscape - birdscape- is a reliable and explicit indicator of the biodiversity decline in terms of sound abundance decrease in natural urban spaces. The regenerative impact of bucolic soundscapes delivered by green urban spaces is therefore drastically reduced by this "loss of audibility" of city natural actors. However, quiet regenerating areas are crucial for anthropic adaptation to the new living conditions provided by increasing urbanization. By promoting biodiversity and ecology, the sanctuarization of quiet areas¹¹ in urban spaces has noticeable advantages regarding the well-being and environmental psychology of inhabitants. The urban model of acclimatization represented by these resourcing areas ensures viability for our noisy, dense cities.

Animal reactions depend on the qualities of perceived threats rather than on the intensity of the resulting noise, not only when the sound is produced by humans (anthropophony) and their technology (technophony), but also when another animal species expresses itself sonically. Therefore, physical approaches of noise quantification (sound level measurement) are unable to reveal soundscapes parameters of this biotic sensitivity to the threats, notably caused by anthropogenic activity. The use of sensory evaluation methods to evaluate ambient components like sound in the environment would be more efficient for that purpose. Thus, we opted for a reduced listening approach (in P. Schaeffer's terms) of the soundscape sources components to reveal the spatial dynamics of territorial sharing between humans and non-humans. This establishes the *presence spectrum* method, developed to describe the extent of inter-species (animals and humans) territorial conflicts, particularly in quiet areas (Bradfer-Lawrence et al., 2019). This acoustic space fractioning method can be operated by a statistical analysis of sound sources cross-observation protocol we present here.

2. Bordeaux ReSonA "Ressourcement - Sonorités - Ambiances" : a quiet areas study

The present research on natural urban environment sound territoriality is part of the ecological restoration project for the benefit of residents through the *LIFE Biodiver'Cité and Resilience* (BCR) program. The acoustic dimension refers to the "quiet areas" component of Bordeaux Metropole's Environmental Noise Prevention Plan. Our approach develops a multi-dimensional hybrid landscape indicator, the *presence spectrum* of sound sources and events, designed to modelize the spatial evolution of the bio- and anthropophonic qualities of the "resourcing" areas (Woloszyn and Ikni, 2023). This method, which has been tested in Mérignac's *Bois du Burck* in 2023, is currently extended to other quiet areas - woods, forests, parks and gardens - in the Bordeaux metropolis. As with any innovative method, this observing tool sometimes delivers unexpected results concerning the "resourcing" territorialized practices of humans and non-humans.

⁹ <https://www.uea.ac.uk/about/news/article/study-reveals-the-shifting-sounds-of-spring>

¹⁰ <https://www.nature.com/articles/s41467-021-26488-1>

¹¹ Sanctuarization recommended by the "quiet areas" section of the European Noise Directive 2002/49/EC.

2.1. Soundscape indicators in quiet areas in Bordeaux: presence spectrum, audibility and proxemics

We will use presence as a tool to assess the overall sensation generated by the combination of perceived sound level and spatiality in the perceptual sphere. It allows us to transcribe the elements in the sound scene by evaluating the listener's *cognitive distance*¹² to the elements of the ambient scene. After being applied to the *Bois du Burck* in Bordeaux-Mérignac, four Bordeaux sites' soundscapes have been evaluated using presence spectrum indicators within those locations: *The Taillan Forest*, *Berges de Garonne*, *Bourghail Forest* and *Bègles Plaine des sports*.

To characterize the spatial soundmark in the semi-urban space of resourcing areas, we use anthropocentric survey techniques to identify the elements constituting the soundscape. For mapping purposes, we deploy a descriptive methodology of the soundscape that combines the enumeration of the heard sound events and the notation of the presence parameters relative to each sound object. The notion of sound presence implies that an ambient object (Woloszyn and Siret, 1998) - in this case, a sound object - can be approached by taking into account two main parameters: the perceptual space in which it unfolds: the dimension (D), and the intensity perceived by the listener: the value (V). The sound presence measurement plane is then represented between the two axes D and V as shown in figure 1:

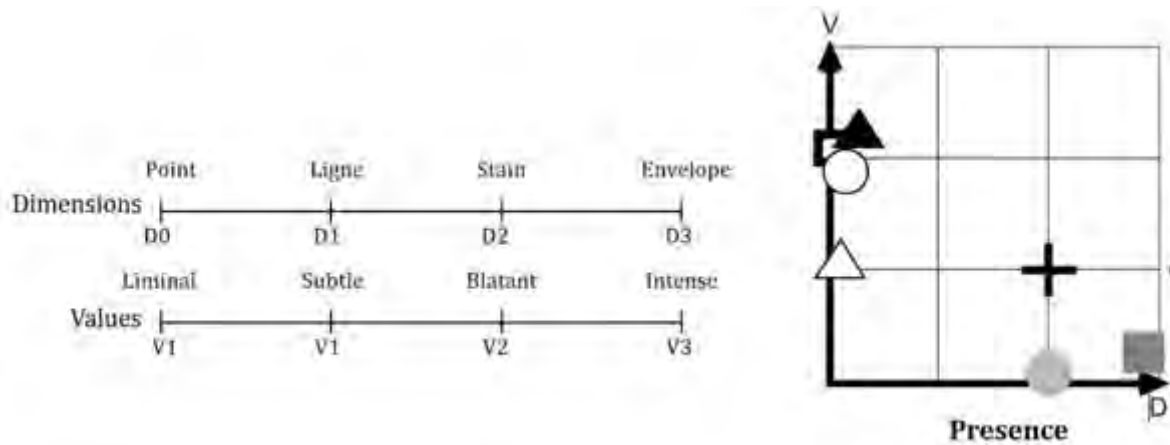


Figure 1. Axes and dimension-value plan, subjective measurement of presence

Presence is an important indicator of the morphological balance between the sources of the soundscape at any moment of listening. As a result of hybridizing the S.A.C.S.SO¹³ method of sound sources analysis with the descriptive method of ambient objects, presence indicator qualifies the *audibility* of the experienced soundscape elements from the sounds scene foreground to its background, as well as the *proxemics*, qualifying the subjective distance from the sound object to the listener (figure 2).

¹² Introduced by Wuits and Nooteboom (2005), the notion of cognitive distance describes the experiential and cultural differentiation of inter-individual perception. It is used here to define the individual's level of involvement within the perceptual act.

¹³ Sound Sequence Composition Analysis System is a methodology for psycho-acoustic analysis of the urban sound environment which is developed by Alain Leobon. See (Léobon, 1995).

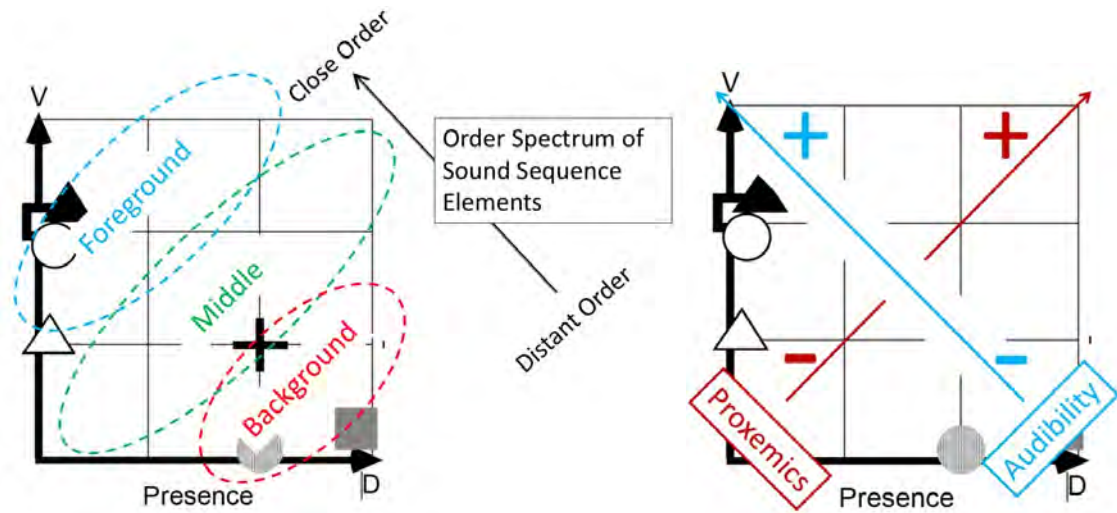


Figure 2. Morpho-hierarchy of sound objects in a soundscape: order spectrum, listening plans, audibility and proxemics

After the processing of the descriptive elements, the results data of the presence spectrum of all the analyzed points are exported to a geographic information system to create a map. The latter is designed to reveal the sound sources territoriality of the site. This cartographic approach of anthropophonic and biophonic sound sources allows us to discretize the sound territories through a dialogical analysis between nature sounds - essentially by distinguishing birds from bugs sounds - and the sounds of human activity - here essentially linked to traffic noise.

2.2. The source-soundmap, territorial battlefield of sonic actors? The example of the Taillan forest site

Forests are a significant part of *Le Taillan Médoc* Township, taking up 25% of its expanse. They cover 451 ha, of which 139 ha belong to the township. Le Taillan's communal forest is made up of hardwoods and maritime pines, with a fairly rich fauna. There are 21 species of terrestrial mammals, 6 species of amphibians, 6 species of reptiles, 71 species of breeding birds, 74 wintering birds, 25 odonates, 6 reptiles, 6 amphibians, 7 chiropterans and 55 rhopalocerans (LPO Aquitaine and Direction de la Nature Bordeaux Métropole, 2015).

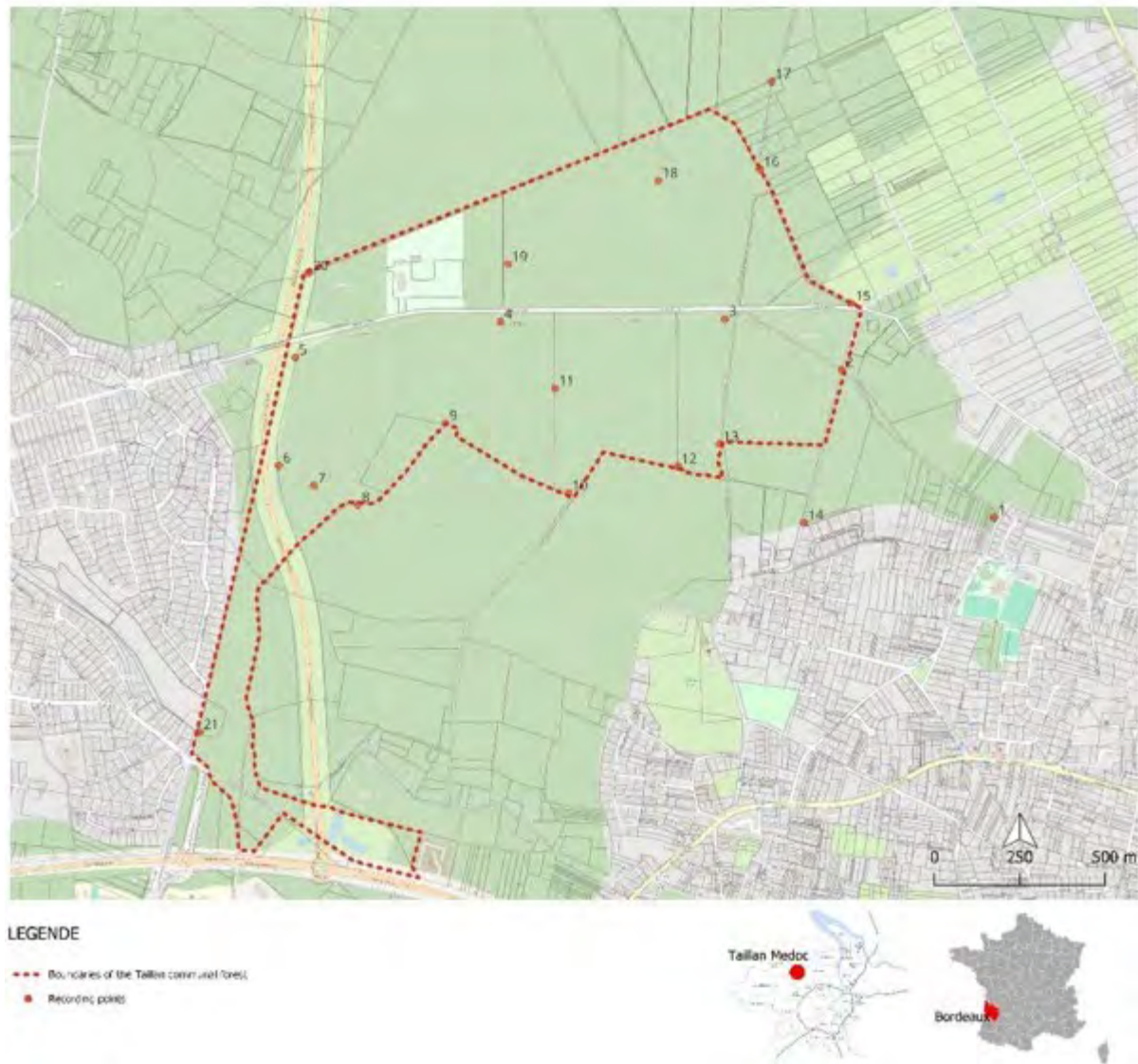


Figure 3. The Taillan forest situation with observation points

2.3. First conclusions on the sound sources territorialization in the Taillan Forest

Following our field surveys, we established several maps showing the location of sound sources audibility level at different times of the day: early morning, late morning and afternoon. The sounds of nature are represented here by two separate maps, showing respectively bird songs and bug stridulations, as seen in figure 4.

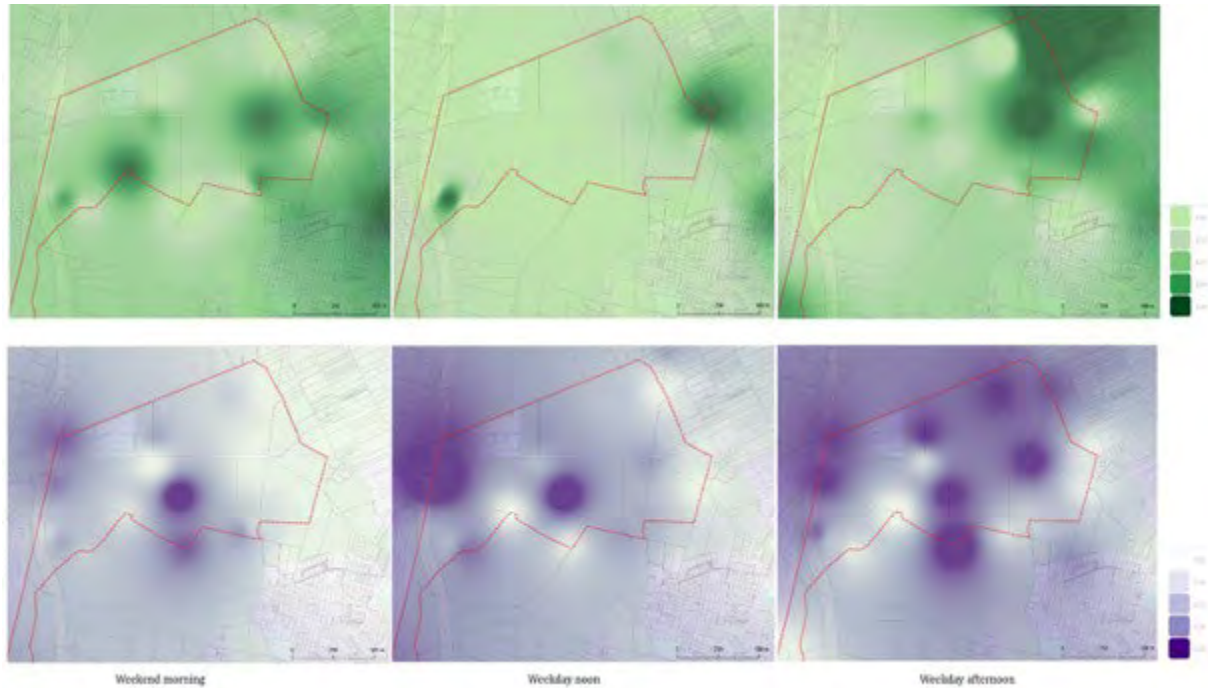


Figure 4. Maps of birds (green) and bugs (purple) audibility

These maps reveal a systematic territorial division, at any time of the day, between the two types of animal sound sources: bird habitats seem to cluster at some distance to the road, i.e., to the east of the territory. In contrast, bugs seem to accommodate to close road noises (figure 5): the food chain between these two soniferous biological groups provides a first explanation of this territorial division.



Figure 5. Maps of urban activity audibility

As the surveys were carried out in fine weather, the bugs naturally congregated in the sunniest parts of the site, the forest bordering the road. Finally, the acoustic adaptation hypothesis (AAH hypothesis) points to an optimal acoustic niche for bugs: indeed, their stridulations seem to adapt better to road noise than birdsongs¹⁴... Several functional ecology studies even confirm that locusts adjust the volume of their stridulation, particularly in the low-frequency part of their spectrum, to adapt their communication when confronted with road noise¹⁵. Ultimately, the explanation for this territorial partitioning between birds and bugs can certainly be explained by these following three factors: food chain, sunlight and song emergence capability.

¹⁴ For birds, the Acoustic Adaptation Hypothesis (AAH) proposes that songs with lower frequencies, narrower frequency ranges and longer inter-element intervals occur more frequently in densely vegetated areas than in herbaceous habitats. See: (Boncoraglio and Saino, 2007).

¹⁵ For bugs, and locusts in particular, the ability to adapt acoustically to the surrounding environment is relative to their ability to modulate intra-species communication signals. See: (Lampe et al., 2012; Lucas, 2019).

The evolution of the presence of sound sources throughout the day confirms a strengthening of animal sources in the afternoon, which seems *a priori* counterintuitive, as bird songs are usually louder at the start of the day. This finds its explanation in the simultaneous presence of bugs, their favorite food, strengthened in the afternoon by the most intense sunshine on the open ground near the road... Moreover, the increase in traffic noise in the afternoon (figure 5), while keeping bird populations away, does not affect the concentration of bugs (figure 4).



Figure 6. Maps of the proxemics of human presence

Besides this, the anthropogenic territorial layout, divided between traffic noise and human presence (figure 6), confirms the relative absence of the latter. While bugs seem to adapt perfectly to traffic noise, they don't seem to enjoy human sound sources, particularly voices. At certain locations within *Le Taillan* forest site, when human presence is at a high level, Bugs remain silent (figures 4 and 6), regardless of the observation period. This fact was confirmed during our soundwalks, when bugs waited for a moment to start chirping again because our arrival at the observation point. Moreover, the impact of these anthropophonic sources does not seem to disturb birds... This could be explained by the dynamic sound structure of human voices which could be assimilated to a predatory sound manifestation for bugs. This is obviously not the case with road noise, which, despite its loudness, can be assimilated to band noise, i.e., white noise without modulation over time, excluding a possible assimilation to a predatory sound emission.

3. Conclusion: soundmaps for landscape planning?

This sound spatialization technique allows us to illustrate the way sounds of nature are inserted into human environments - in this case, essentially mechanized - and to draw conclusions about the logic of urban - or landscape - planning. A first conclusion could concern reasoned mowing of roadsides, which takes on its full meaning here: indeed, the configuration we just observed seems to assimilate roadsides at the edge of forests with privileged natural biotopes for bugs. In fact, bugs are sonically protected by road noise, which keeps their main avian predators away. Within circulated environments, they seem perfectly able to adapt their stridulations to communicate with their congeners for feeding and, above all, reproduction purposes. Following those "ideal" conditions, roadsides seem to constitute natural reservoirs for stridulating bugs, insofar as wild flora and vegetation are neither treated with pesticides nor eliminated by humans.

Thus, soundscape is a reliable and explicit indicator of the co-evolution of biodiversity in resourcing areas. Soundscape analysis makes it possible to process vital information for the anthropic reallocation of natural areas, which can be seen as the side effects of climate change, which is usually *silencing nature*. This tool for spatial observation of the evolution of living sonic territories opens up the instrumental perspectives of a bio- and anthropophonic observatory on an urban scale, to detect the co-evolutionary factors of the ecological functioning of soundscapes, thus facing the effects of anthropogenic disturbances on the urban resourcing environments biodiversity.

Artificialization, climate change, light and noise pollution are just some examples of the threats that affect biodiversity in today's cities. By targeting several pilot sites in Bordeaux as experimental laboratories, the aim is twofold: to keep and raise citizens resourcing needs and to promote biodiversity by focusing solely on one taxon (avifauna). Annually monitoring an abundance indicator will allow us to draw a parallel between sound ambience and the assessment of animal species.

This research has demonstrated that the evaluation of sound sources presence is important to assess the weight of each species in the living space shared between humans and non-humans. To explain certain phenomena, this type of information is crucial to evaluate the richness of the soundscapes we are listening to. Furthermore, this research opens up the instrumental perspectives of a bio- and anthropological observatory. It is likely to detect the factors that influence the ecological evolution of soundscapes facing the environmental disturbances due to the anthropization of our landscapes.

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Echoes of Embodied Experiences: Walking Methodologies for Sensorial Research

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Abstract

Urban environments are characterized by their physical structures and the rich tapestry of sensory experiences they offer their inhabitants. However, conventional methods of assessing urban experiences often privilege the tangible and visible aspects and the nuances by which these influence social practices and the use of public space. A sensory approach to urban environments emphasizes the multifaceted nature of human perception, highlighting the importance of sensory experiences in understanding interactions with surroundings. This article presents the results of field research at Lisbon's Oriente Station. Using shadowing and sound recording as sensory methodologies, researchers observed the walk of a blind person within the different areas of the station, focusing on auditory stimuli and mapping his journey while arguing for the need of unconventional studying methodologies. The two proposed methodologies proved effective in uncovering hidden dimensions of urban experience.

Keywords

sensorial approach, shadowing, sound recording, ambiances, urban environments

1. Exploring the Sensory Dimensions of Oriente Station's Architectural Design

Oriente Station, designed by Spanish architect Santiago Calatrava, is one of the many architectural landmarks created during the Lisbon International Exhibition (Expo '98). This event led to the development of the Parque das Nações district, establishing a new urban centre for the city of Lisbon. Located east of the city centre, Parque das Nações emerged from a large-scale urban regeneration project that transformed a former industrial dockland area along a 5 km stretch of the Tejo River waterfront. Although the area has faced local criticism as a project of financial engineering, territorial marketing and gentrification, what stands out is its conceptualization as a space of consumption—a commodified area that is socially distinct and representative of a unique urban lifestyle, one which may feel out of reach for many Lisbon residents.

Parque das Nações introduces a high-end, carefully curated urban environment that caters to affluent consumers and travellers. The upscale establishments and exclusive residential developments here shape the area into an enclave, symbolically and socially detached from the broader city. Many locals describe it as a “vacation” or “magical” place that can transport its inhabitants into “parallel dimensions, both temporal and spatial” (Gato, 2012). This branding highlights the area’s detachment from everyday life, where multiple atmospheres are constructed to attract ‘consumers’ with certain expectations and resources. In turn, these spaces invite a specific set of social activities and visitor demographics, reinforcing homogeneity over diversity and aligning with the controlled exclusivity typical of high-end commercial areas. The area materializes as a mixed residential and commercial district, surrounded by meticulously curated public spaces that offer visual appeal but risk limiting inclusive social engagement.

Within this fragmented urban territory—seemingly alien and isolated from Lisbon’s historic core—lies Oriente Station, a multimodal hub where metro, buses, cars and trains converge across three levels, functioning as a gateway to the district. This station represents a unique architectural form, yet its grand design and function

characterize it as a 'non-place,' to use Marc Augé's (1996) term. Despite its architectural grandeur, Oriente Station (Figure 1) functions more as a transient space than one that fosters social bonds, where anonymity prevails. The commodified environment within and around the station further prioritizes consumer interactions over community connections, deepening the sense of detachment.



Figure 1. Aerial view of Oriente Station in Lisbon

To study the lived experiences of people in spaces like Oriente Station, we employed a sensory approach, emphasizing how individuals perceive and interact with the environment through their senses. Specifically, we conducted sensory ethnography (Pink, 2009), immersing ourselves in the station's daily life, recording detailed field notes and capturing audiovisual material. By focusing on sensory experiences, we explored how this architectural design influences feelings of alienation or belonging and how the ambient sounds contribute to the station's overall atmosphere. Understanding these sensory interactions provided insights into how sound design affects lived experiences, highlighting the potential to optimize public spaces for human enjoyment by attending more closely to their auditory characteristics.

Our findings also suggest that the particular design and sensory features of Oriente Station, while visually captivating, contribute to its status as an exclusive space that is challenging for broader social inclusivity. This orientation toward a commodified public experience—one that feels crafted, controlled and isolated from the rest of Lisbon—invites reflection on how urban design can either bridge or deepen socio-spatial divides. Instead of fostering open, diverse social interactions, the area's controlled environment emphasizes a commodified, touristic version of public space, where the broader population may feel like outsiders.

2. Embodying the Urban Experience: Walking, Listening and Understanding

Building on this sensory approach, our study proposes walking as a key method to engage with the nuances of urban spaces like Oriente Station. Walking—an embodied, experiential interaction with space—allows researchers to access the rhythms, textures and structures that define urban landscapes. This phenomenological approach foregrounds the sensory qualities of everyday life, transforming walking into a conduit for understanding spaces beyond their physical boundaries (Careri, 2002; Ingold & Vergunst, 2008). As Certeau (1984) notes, walking is more than mobility; it is an interpretive act that “writes” the city, turning each step into an engagement with history, community and the stories embedded within urban spaces.

To apply these principles specifically to Oriente Station, we used two sensory methodologies: shadowing and sound recording. These methods reveal the lived experiences of individuals as they navigate this unique urban environment, illuminating how sensory perception intersects with socio-spatial interactions. Shadowing allows

researchers to observe how users respond to spatial cues, while sound recording captures the auditory atmosphere that shapes user interactions, providing a multidimensional understanding of how design impacts human experience in public spaces (Augoyard & Torgue, 1998).

By combining these methods, we are better equipped to understand Oriente Station’s social dynamics, recognizing how sensory design elements influence perceptions, behaviours and the inclusivity of urban spaces. Together, these approaches contribute to a deeper insight into the ways architecture can both include and exclude and how immersive methodologies help uncover these nuanced layers within public spaces.

2.1. Shadowing as an Intersubjective Exploration of Space

Shadowing is a qualitative ethnographic research methodology, originally rooted in organizational studies (McDonald, 2005), but increasingly recognized in all social sciences, specifically in urban environments for its ability to reveal the nuances of everyday life (Sclavi, 2005; Cerulo, 2015), but also in the context of disability studies (van der Weele & Bredewold 2021) and sound studies (Biserna, 2022). Through shadowing, researchers follow and closely observe a subject in their usual environment, documenting movements, actions, and interactions within specific social, spatial and temporal contexts. This immersive approach captures subtle behaviours and embodied interactions, providing a window into the sensory and spatial dynamics that influence the subject’s navigation and sense of place (Czarniawska, 2007; Quinlan, 2008).

Shadowing as a technique extends walking by situating the researcher alongside participants, allowing for real-time observation of their sensory interactions within the environment. This approach foregrounds intersubjectivity—how the environment is jointly experienced by the researcher and subject—highlighting nuances of spatial use, personal navigation strategies and the sensory cues guiding movement (Sclavi, 2005). The act of shadowing invites researchers into the subjective space of others, facilitating a shared exploration of urban environments that transcends observational detachment.

By immersing oneself in the participant’s experience, shadowing bridges the personal and collective dimensions of perception, revealing how urban spaces accommodate diverse needs and preferences. In this way, the technique not only captures meta-contextual data but also enriches our understanding of social spatiality as it unfolds in situ.

In our study, shadowing was adapted to capture the experience of a visually impaired individual navigating Oriente Station, offering insights into how environmental sound cues aid in orientation and influence spatial use. By observing without intervening, we recorded the subject’s route, pauses and interactions with space, documenting how they engage with sounds and other non-visual cues for navigation. This method provided access to a daily life scenario little familiar to us (researchers), revealing how sound shapes human perception, behaviour and emotional responses to space. Shadowing thus brings a crucial human-centred perspective, enhancing our understanding of spatial dynamics often overlooked in traditional urban studies.

2.2. Sound-Recording: Capturing the Auditory Dimensions of Space

Sound recording is equally significant in exploring sensory experiences in urban spaces, capturing the aural atmosphere influencing user interactions and perceptions. Different approaches to sound recording capture various sound qualities, as theorists like Schafer (1997) and Schaeffer (2017) note—whether by focusing on sonic content (e.g., frequency, rhythm) or by analyzing sound effects (Augoyard, 2006) or Acoustic Ecology. The auditory data gathered offers a distinct layer of spatial information, enabling us to identify how overlapping sounds—footsteps, transit, ambient noises—create what can be described as a “combinatorial sound space.”

In Oriente Station, the layering of diverse sounds creates a dynamic, ephemeral soundscape where public transport, commerce and social activities intersect. Our initial impression of the station as an expansive, architecturally polished space gave way to a more nuanced understanding through sound. By recording and analyzing the overlapping sound layers, we captured the non-visual boundaries and transitions in the space. This auditory mapping revealed how sounds contribute to users’ emotional responses, providing cues that shape comfort, orientation and a sense of connection to the space.

Shadowing and sound recording offer complementary insights: shadowing grounds our understanding of the user’s embodied experience, while sound recording contextualizes these interactions within the broader sensory environment. This combined approach yields a holistic perspective on Oriente Station’s socio-spatial dynamics,

emphasizing how sensory elements shape user behaviour and perception. Such a multisensory analysis highlights the potential of sound design and sensory-sensitive planning to enhance public spaces for diverse urban experiences, aligning with broader goals of inclusivity and human-centred design in urban studies.

Building on Westerkamp's (1974) and Schafer's (1997) foundational work, sound recording captures the continuous, interwoven sounds that characterize urban life. This auditory dimension reveals spatial and temporal rhythms shaping people's experiences in ways that visual observation alone cannot. Soundscapes also help contextualize navigation, providing clues about a location's layout, materiality and emotional resonance. For instance, sounds of footsteps, conversations, traffic and ambient music combine to form a unique sound signature for each space. Analyzing these auditory cues allows researchers to understand how soundscapes impact orientation, comfort and the formation of emotional associations with specific locations, which is essential for understanding urban spaces as dynamic, multilayered environments where sounds profoundly shape perceptions and behaviours.

2.3. Toward an Experiential Epistemology

Together, walking, shadowing and sound recording form an experiential epistemology—a method of knowing through embodied, sensory engagement with the world. This approach challenges dominant forms of knowledge production, which often prioritize abstract, detached perspectives. Instead, it proposes that understanding emerges from immersion, from feeling the contours of space through movement, sound and touch. Through this methodological framework, researchers access forms of knowledge rooted in lived experience, recognizing the social, temporal and sensory dimensions that shape how we perceive and inhabit urban spaces.

The methods of shadowing and sound recording, in particular, provide complementary insights into the socio-spatial dynamics of Oriente Station. Shadowing immerses us in the embodied experience of users, while sound recording contextualizes these interactions within the broader sensory environment. Together, they offer a holistic perspective that highlights how sensory elements influence user behaviour and perception. This multisensory analysis emphasizes the potential of sound-sensitive and inclusive urban planning to foster human-centred public spaces.

By embracing these methodologies, we gain a deeper appreciation for the intricacies of urban life, often hidden from conventional research approaches. Sensory methodologies such as shadowing and sound recording allow us not only to document but also to experience and interpret urban landscapes as they are lived, revealing the complex, layered nature of the environments we inhabit. This immersive approach enriches our understanding of daily experiences, providing insights into the broader structural dynamics and personal histories that inform our interactions with urban spaces.

3. Notes from the field

Following the methods and context outlined above, shadowing and sound recording of the subject, referred to as "Alex," were conducted on November 28, 2022, from 14:00 to 15:23. For the sound recordings, two distinct modalities were employed: an on-the-move recording, lasting 5 minutes and 15 seconds, and a stationary recording, lasting 4 minutes. These two modalities allowed for capturing the dynamic and ambient soundscapes of Oriente Station.

During this observation period, the researchers accompanied Alex closely. One researcher documented each area he moved through, noting the specific activities he engaged in and any social interactions he encountered. Meanwhile, the second researcher concentrated on sound recording, capturing the auditory dimensions of Alex's journey. This coordinated approach provided comprehensive insights into both the spatial and sensory experiences of Alex as he navigated the station.

3.1. Shadowing findings and discussion

Alex engaged in various activities, including smoking, taking a coffee break, shopping and performing banking transactions. While each activity was completed relatively quickly, it is noteworthy that requesting assistance in navigating certain areas required more time, highlighting the challenges that visually impaired individuals face in accessing specific spaces.

Despite the station's complex, dynamic environment, Alex displayed notable familiarity with the area, skillfully navigating two floors using escalators and tactile feedback from his guide stick. He actively sought assistance when needed, demonstrating a proactive approach to overcoming spatial barriers. We also observed moments when passersby spontaneously offered support.

Figure 2a illustrates the activities Alex performed and the time spent on each. The axes represent the locations Alex visited in chronological order, from the smoking area to the bus station. At the same time, the distance from the centre indicates the time spent at each site (in minutes). Two locations—an optical shop and an information point—stand out as areas where Alex spent considerable time waiting for assistance to navigate. This highlights that certain areas, particularly within the station’s mall corridor, pose significant navigational challenges for visually impaired individuals. The need for assistance not only delays the individual requiring help but also impacts those providing it.



Figure 2a. Time it Took Alex to perform different activities

We also analysed Alex’s emotional responses by observing facial expressions as he moved through various spaces within Oriente Station, both indoors, outdoors and in transitional areas. Figure 2b illustrates the range of emotions observed in different parts of the station. Outdoor spaces predominantly evoked positive emotions, such as relief, wonder, joy and enjoyment. Conversely, indoor and transitional spaces elicited a wider range of emotions, from negative feelings like confusion and frustration to moments of relief and gratitude in response to earlier challenges. Categorizing these emotional states offers insight into how distinct spatial environments affect emotional well-being, underscoring the importance of thoughtful design in shaping such experiences.

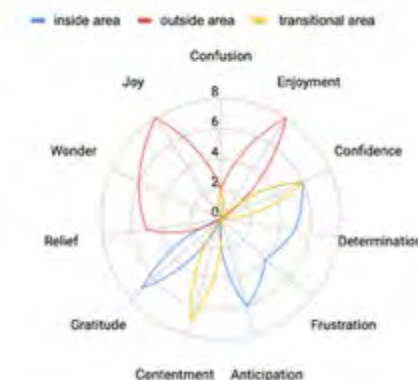


Figure 2b. Alex's emotional states in the spaces he visited

3.2. Sound-recording findings and discussion

For sound recording, a set-up of Soundman OKM-II binaural microphone setup with a pre-amplifier (Soundman A3) connected to a Tascam DR-40 recorder, was used, set to an input level of 75. The binaural recording technique was chosen to capture the spatial characteristics of the sound environment, allowing us to locate and position sound sources spatially within the recording. This technique is ideal for capturing the acoustic complexity of a large, socially active space where numerous spontaneous sound events simultaneously. The pre-amplifier

and input level were calibrated to capture both subtle sounds created from within the station’s interior, minimizing distortion from loud, unexpected sounds.

3.2.1 “On-the-move” sound-recording

Figure 3 shows the first of the two recordings, in the on-the-move modality, that we conducted in Oriente Station while shadowing Alex. In this segment, the ambient interior sounds shift between foreground and background as Alex and the sound source move through the space. The soundscape includes distinctive markers such as bus and train brakes, engines, conversations, footsteps, laughter, store music, shopping carts and coffee shop cutlery. Though recorded indoors, the sound ambiance occasionally transitions to an “outdoor” quality due to the station’s architecture and the permeable canopy, allowing exterior sounds to blend with the interior atmosphere.

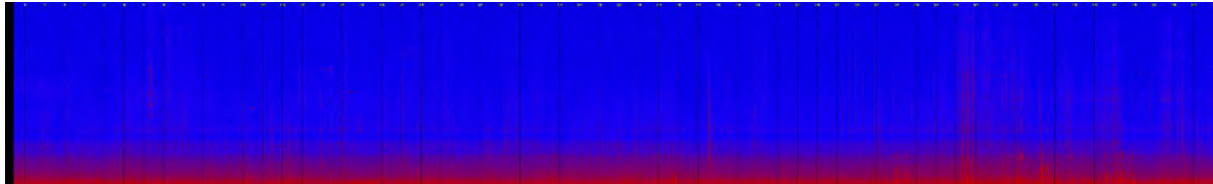


Figure 3. “On the move” recording of Alex's itinerary within the Orient Station, duration 5.15 minutes

Because this recording follows Alex, the sound of his guide stick tapping on the floor is a prominent feature, as shown in Figure 4.

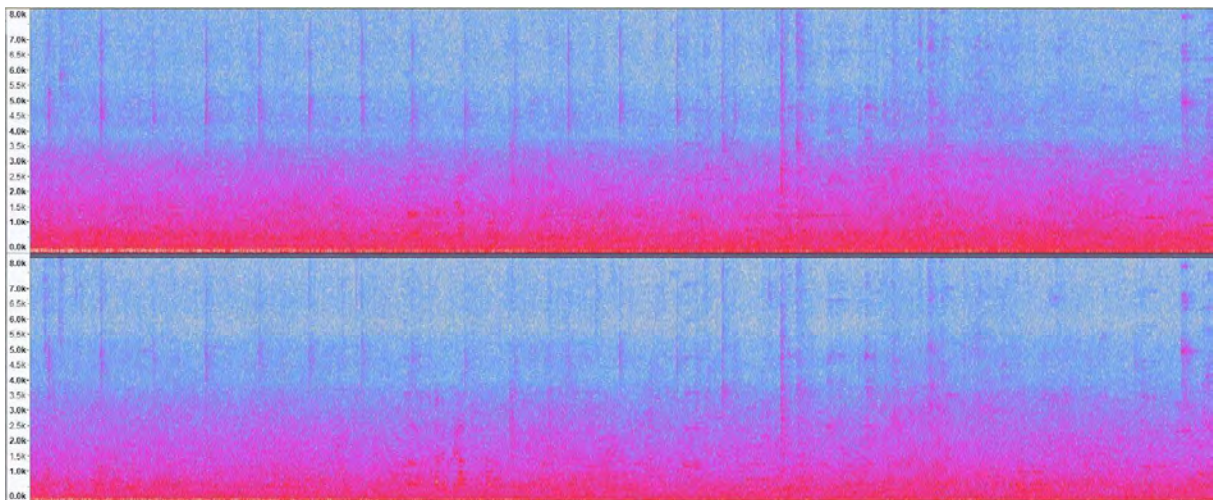


Figure 4. Spectrogram moment from Alex's shadowing where the blind stick can be noted

Though the recording is not calibrated to a sound meter, we analyzed the decibel (dB(A)) levels within a frequency range of 100 Hz to 16 kHz. A maximum fluctuation of 34.7 dB(A) across the frequency spectrum is observed, with a band-pass filtering effect that includes mid-range frequencies and a drop of approximately 15 dB(A) in low frequencies and 30 dB(A) in high frequencies.

3.2.2 “Stationary” sound-recording

Figure 5 shows the second of the two recordings, in stationary modality, that we conducted in Oriente Station while shadowing Alex. In this recording, the captured soundscape conveys an exterior ambiance, with sounds transitioning from background to foreground. Key auditory markers include car horns, traffic sounds, music from portable speakers and conversations, creating a vibrant sound scene. The canopy’s reverberant acoustic quality gives the sense of an enclosed space, even outdoors, acting as a noise buffer and emphasizing sounds occurring beneath it. This structure gives an acoustic dimension that differentiates the ambiance from the surrounding urban environment.

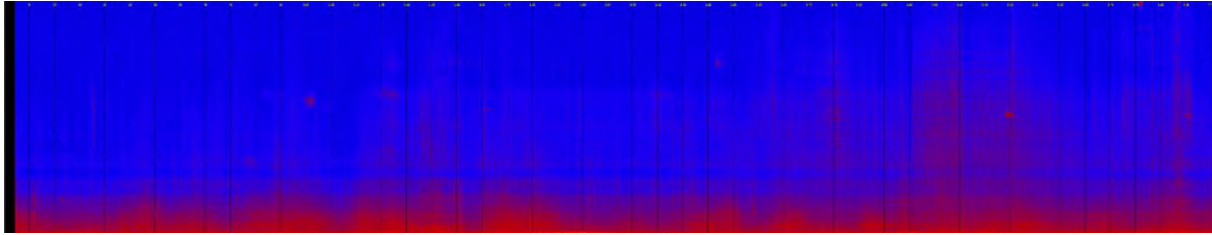


Figure 5. Static recording of Alex's itinerary within the Orient Station, duration 5.15 minutes

While the binaural set-up is not calibrated to a sound meter, the sound field recording dB(A) analysis presents a maximum of 30.3 dB(A) fluctuation in the frequency spectrum. This recording also exhibits band-pass filtering, with a 2 dB drop in mid-range frequencies and approximately 15 dB(A) drops in both low and high frequencies.

3.2.3 Stationary sound-recording

In both soundscapes, certain patterns emerge, as shown in Figure 6. The large volume under the canopy contributes to pronounced reverberation, with low frequencies expanding to form a background “carpet” effect. The soundscape’s periodicity, as users move through the space, results in background sounds gradually shifting into the foreground and vice versa. The decibel comparisons between indoor and outdoor settings show minimal differences in the selected frequency spectrum, with the most noticeable variation in higher frequencies.

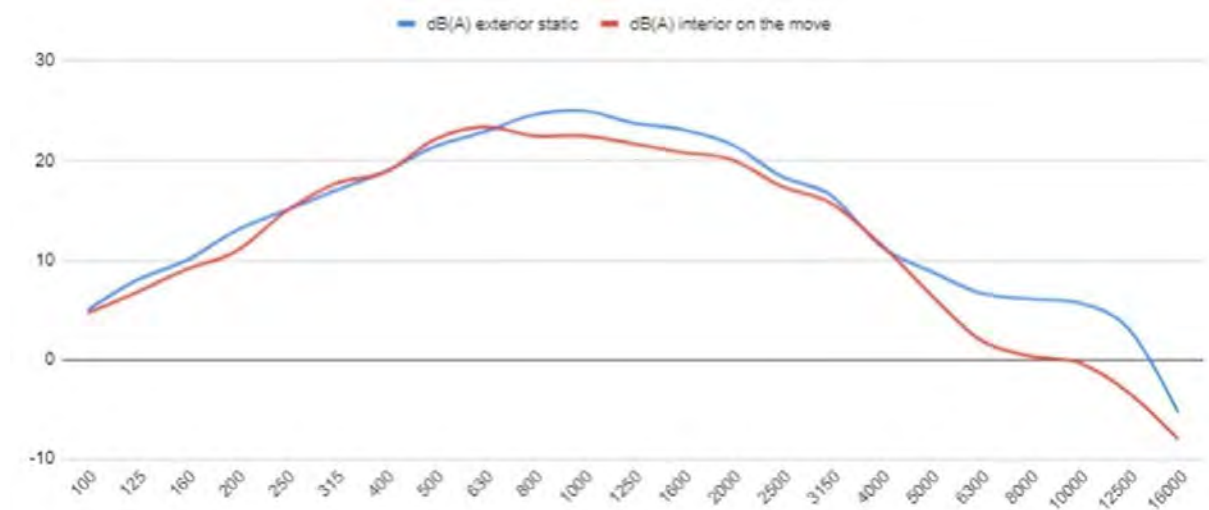


Figure 6. Comparing the field recording dB(A)

4. Conclusions

In this case study, we adopted non-standard methodologies to adapt to the indeterminate character of an uncertain architectural space. We believe that, during an in situ study, it is common to act impulsively and instinctively due to the unique opportunity to capture events that occur unexpectedly. This paper argues for the value of taking risks to explore captured events, even when limited data is available, rather than avoiding their study altogether. Greater application of these unconventional methodologies would likely allow us to evaluate their contributions and limitations more accurately and comprehensively.

A defining feature of the sensory research methods employed here is the empathy of the researcher, who through their body and senses immerses themselves in the spontaneous behaviours and events encountered with the subject. This immersive approach enables a deeper understanding of the situations and context in which both the researcher and subject experience the space together.

In observing the soundscape of Oriente Station, we were surprised to note that our subject demonstrated greater agility in outdoor spaces compared to indoor areas. This finding suggests that the indoor soundscape may be cluttered, with a lack of “natural” sounds that could otherwise aid orientation for visually impaired individuals.

An alternative explanation is that outdoor movement is facilitated by the distinct sound of the stick's contact with the pavement, which is more pronounced outside than indoors. However, it is worth noting that neither indoor nor outdoor areas have dedicated signage for visually impaired users.

Lastly, it is interesting to observe that the architecture of the space, with its deliberate openings and closures designed by Calatrava, can be interpreted through the blending of internal and external sounds within its context. This cacophony offers insights into how architectural design choices impact the sensory experience of space.

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Soundscape of Agia Paraskevi Cave (Skoteino, Crete, Greece)

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Abstract

The representation of the sonic environment has received increased attention, concerning the capture of biological, geophysical and human sounds. As far as ecology is concerned, collection and analysis of sound recordings contributes to wildlife monitoring and conservation planning. Caves and karst are little studied, vulnerable ecosystems even though they host a variety of animal species with unique adaptations and they provide valuable ecosystem services. To our knowledge, cave soundscapes incorporating ultrasounds have not been examined, prompting us to develop an innovative research concept: divide the Agia Paraskevi Cave (Skoteino village, Crete, Greece) to ecozones, partition a day to time-periods, and meticulously investigate spatial and/or temporal soundscape variations. The examination of the sound recordings validated our hypotheses that the presence/absence of specific taxa's sounds depends on their habits. The presence of taxa that emit ultrasounds could be reliably quantified thanks to the use of loggers that record a wide frequency spectrum. Besides, breeze out of the cave, ventilation inside the cave etc. were quantified (number of files containing geophysical sounds) as well as human presence. Hopefully, by this contribution a new focal point may be created in cave studies.

Keywords

Sound events, soundscape, classification of sounds, ecology, ecozones of caves, temporal variation, Agia Paraskevi Cave

1. Introduction

1.1. Perception of environment based on sounds

Visual cues alone are insufficient to acquire comprehensive knowledge about a landscape, including the documentation of all fauna and flora inhabiting an area or the recording of all non-biological ambient processes. The auditory properties occasionally allow for the identification of biological or human activities that are difficult to discern during conventional surveys (Klingbeil & Willig, 2015; Astaras et al., 2017). The soundscape of each landscape is distinct (Schafer, 1977; Farina & Gage, 2017:235) but a mere snapshot of acoustic data is insufficient to establish the acoustic signature of an area. Data should be acquired on various meteorological conditions and temporal intervals, such as seasons and times of day (Pijanowski et al., 2011:209; Farina & Gage, 2017:31,33).

1.2. Wildlife monitoring challenge

Acoustic ecology is an emerging field of ecology that investigates the role of acoustic signals at the level of the organism, biocommunity, or landscape (Sueur & Farina, 2015). Wildlife acoustic monitoring has been utilised for

a diverse array of animals, including birds, amphibians, insects, shrimps, fish, terrestrial or marine mammals etc. Passive Acoustic Monitoring (PAM) enables prolonged continuous surveys with low manual effort and increases the probability of detecting rarer or less vocally active species (Klingbeil & Willig, 2015). Recent advancements in sound recording technology have led to the availability of low-cost data loggers, enabling researchers to record the acoustic activity at various sites over extended periods (Hill et al., 2018, Roe et al., 2021). Recent advancements in sound analysis techniques are expediting and simplifying the examination of extensive data sets (Bas et al., 2017; Gibb et al., 2018).

1.3. Cave soundscapes

Caves have facilitated study in archaeoacoustics, psychoacoustics, music cognition, and ecomusicology (Reznikoff, 2008; Till, 2019; Chabashvili & Asitashvili, 2024; López-Mochales, 2024; Pham & Fletcher, 2024). In addition to social sciences and humanities, natural sciences concentrate on the sounds and ultrasounds produced by cave-dwelling animals, particularly bats (Klopper et al., 2016; Whiting, 2022). Still, to our knowledge, no cave ecosystem around the world has been examined by soundscape ecologists using the methodologies applied to urban (Pijanowski et al., 2011:210-215) and natural environments (Matsinos et al., 2008; Papadimitriou et al., 2009), quantifying the three fundamental components of a soundscape: anthrophony, biophony, and geophony.

1.4. Study Area

Agia Paraskevi Cave is a karst formation situated at 220m a.s.l., 1.2 km northwest of Skoteino village, on Crete Island, Greece (35.30476, 25.29764, Fig.1a) (Paragamian & Legakis, 1986; Paragamian, 2024). A 25 x 25 m doline has been formed as a result of a fall of the roof, preceding the entrance to the cave. The cave itself consists of three zones: (a) the entrance (light zone), (b) a big, impressive gallery, 134 m long, 33 m wide and 30 m high (twilight zone), and finally (c) a smaller chamber measuring 18 x 12 m (dark zone) (Tyree et al., 2014, Fig. 1b). Although it's not officially a show cave, several thousand people visit Agia Paraskevi Cave every summer.

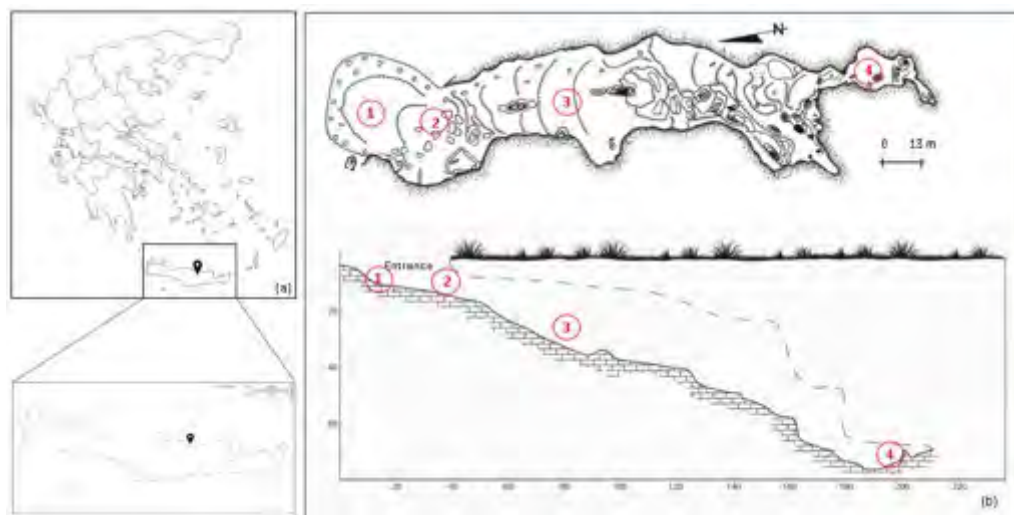


Figure 7. (a) Map of Greece indicating Agia Paraskevi Cave (Skoteino, Crete, Greece) location, (b) Plan view and profile view of Agia Paraskevi Cave, modified from Tyree et al., 2014

2. Methodology

2.1. Sampling design

In early fall 2024, we deployed recordings of sounds and abiotic data at Agia Paraskevi Cave for a complete day (24 hours). We established four stations (Fig. 1b), commencing from the surface environment preceding the cave entrance, where a doline is situated (Station 1). The subterranean space was divided into three sub-areas according light intensity: entrance zone (Station 2), twilight zone (Station 3) and dark zone (Station 4). In each station, a 120-minute sound-recording observation was carried out, using automatic, full-spectrum AudioMoth

loggers (Hill et al., 2019), while hourly measurements of air temperature, relative humidity and luminance were recorded by Troglometers, low-cost devices that were developed in the framework of LIFE GRECABAT Project. Each 120 min observation was subdivided into 480 sequential time-steps (of 15 s), resulting in time series data. Surveyors dedicated the day close to the doline to document visitor presence in the cave and subsequently correlated the visual observations with the audio recordings.

The desired sound sample was extensive, and the sampling design was rigorous. Terrestrial soundscape surveyors usually focus on recording the audible sounds. Wildlife surveyors focus on the frequency spectrum of vocalisations emitted and sounds produced by the animals to be monitored, e.g., birds and frogs (audible signals), bats and odontocetes (ultrasounds). In our case, we aimed to record both audible sounds and ultrasounds (some of which may exceed 100 kHz). Prior to conducting fieldwork in the study area, we performed pilot sound recordings using various settings at Oasis Park, Irakleion, to ensure that our tailored configurations would effectively capture all the sounds of Agia Paraskevi Cave. We selected Oasis Park due to the known presence of both avian and chiropteran species, as well as human activities. Subsequently, we examined a sample of the obtained data for sound events that could be classified as biophony, geophony, anthropophony. Upon analysing the datasets, we concluded to set the sample rate to 384kHz, a medium gain, a band-pass filter of 0 to 144 kHz, an amplitude threshold of -36 dB and a minimum trigger duration of 15 seconds while configuring the AudioMoths.

2.2. Treatment of acoustic data

To detect and classify all sound events, we processed WAV files using a group of software and listened to them as well. Auditory observation, spectrogram analysis, and labelling of each sound occurred in two phases: (a) a phase focused on audible sounds and (b) a phase focused on ultrasounds.

Processing commenced with Kaleidoscope (version 5.3.9) from Wildlife Acoustics, which enables the manually labelling of each .wav file while observing the spectrogram, and the preservation of those labels. A .csv file is generated with a number of rows according to the number of wav files, with a designated column labelled "MANUAL ID" for storing the labels. The Manual ID for each observation is stored in a single cell, with each label comprising three distinct sub-labels, separated by a symbol; for example, 0_1_0 indicates absence of anthropophony, the presence of biophony and the absence of geophony. Biophony was considered to be present if either audible or ultrasound components were detected in the .wav.

The software processing was essential for both categorising all sound events and identifying the taxa accountable for the biotic sounds. Biophony can be detected and classified as a certain species by algorithms utilising sound libraries of the adequate geographical area (Bas et al., 2017; Noda et al., 2013). The algorithms we used for our analysis were developed by the British Trust of Ornithology (Dr. Stuart Newson) in collaboration with Greek researchers, who provided bat sound reference data. They operate in the programming environment of R language (RStudio) and they pre-require the treatment of sounds on TadaridaL. In the end of the processing a csv file with Auto-ID suggestions is generated. A manual cross-check of the suggested species is considered necessary. On the other hand, there is no algorithm to date, that can reliably identify cars, human vocalization, rain or wind, using acoustic indices such as amplitude of the acoustic energy (Fairbrass et al., 2017; Quinn et al., 2022). Due to the limited size of our dataset, we classified manually all geophonic and anthropophonic events after audition, using Kaleidoscope software.

2.3. Classification and quantification of sounds

Following the analysis of the acoustic data using software, we quantified the contribution of the three basic components (anthropophony, biophony, geophony) to the soundscape of each station, during a 24 hours period. We examined the hourly variations of the contribution of each sound category to the soundscape of each ecozone. More thoroughly, we quantified the contribution of different taxa to the biophony recorded at every station and calculated the % contribution of biophonic observations across several frequency spectra (audible spectrum, ultrasonic spectrum, overlapping spectra).

3. Results

3.1. Abiotic environment

Temperature (T), relative humidity (RH), and illuminance varied per station. The cave's temperature remained consistent during the 24-hour period, with the exception of the doline (Station 1). Commencing at Station 1 and progressing into the innermost chamber of the cave, the mean daily temperature exhibited a decline: $T_{ST1}=25.6^{\circ}\text{C}$, $T_{ST2}=21.3^{\circ}\text{C}$, $T_{ST3}=17.8^{\circ}\text{C}$, $T_{ST4}=13.4^{\circ}\text{C}$. Relative humidity (%) remained constant throughout the day solely at Station 2 and Station 4, both recording 100% due to water condensation on the sensors. At Station 1, relative humidity was 100% prior to dawn, progressively diminished post-sunrise, maintained values over 60% during the day, and gradually ascended to 100% again at night. At Station 3, relative humidity exhibited an inverse pattern: it rose post-sunrise and declined post-sunset, remaining above 80% at all times. Ultimately, illuminance (lux) measurements yielded remarkable, unequivocal results: the recorded illuminance corresponded closely to variations in solar activity, diminishing in intensity with increasing depth. In Figure 2, we eliminated all elevated values of sunshine to concentrate on smaller size classes and illustrate the differentiation of various ecozone environments. The elevated illuminance measured at sunset at Station 2 relative to Station 1 represents an anomaly. At that time period two visitors were recorded visiting the place and spending time at Station 2. Probably, due to their torch, artificial light was collected by the Troglometer's light sensor.

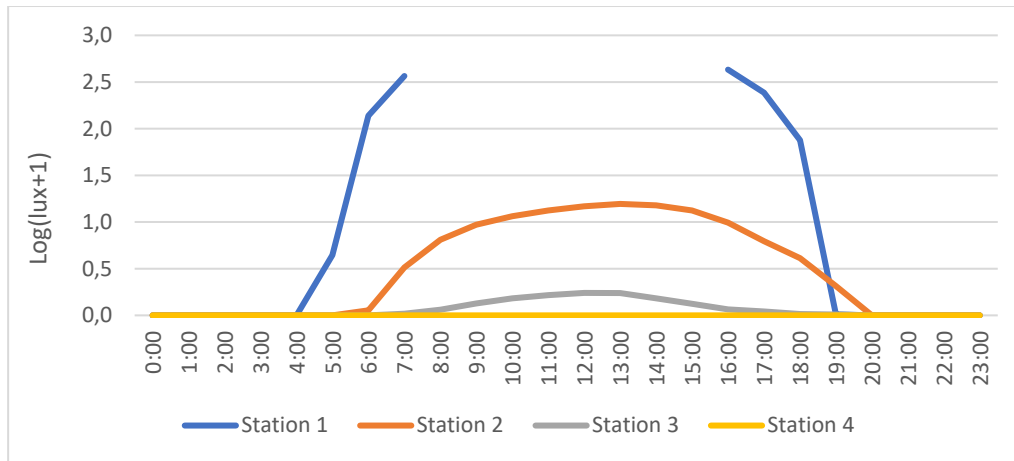


Figure 2. Illuminance in four different ecozones of Agia Paraskevi Cave, Skoteino, Greece

3.2. Acoustic observations per station

During a single day of September 2024, a total sum of 1.409 acoustic observations, spanning 480 minutes, were recorded in Agia Paraskevi Cave and the preceding doline. The observations of each station were classified as anthropophony, geology and biophony. Approximately 80% of the sound occurrences were classified as biophony. Humans' presence was mainly restricted to the first three stations and geophysical sounds were recorded solely at the two first stations (Fig. 3).

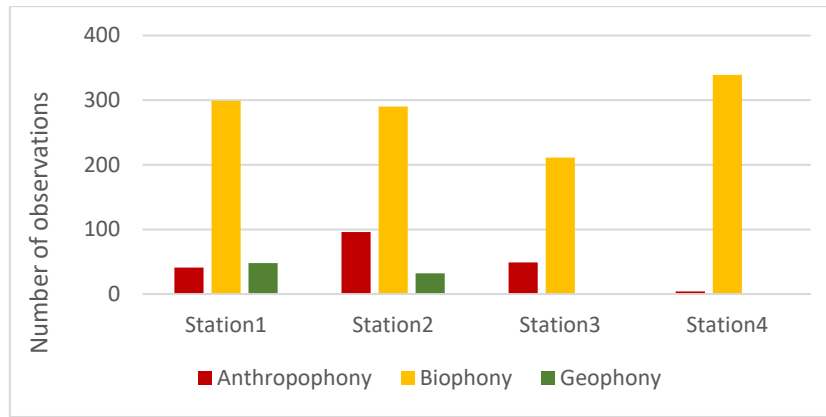


Figure 3. Total number of acoustic observations recorded in Agia Paraskevi Cave, during a single day, per station, split into anthropophony, biophony and geophony

3.2.1. Biophonic sounds: biological classification and frequency spectra taxonomy

Upon meticulous listening, evaluating the algorithms' recommendations, and analysing the spectrograms of biophonic events, we identified a lot of organisms at level of species, genus, family or at least class (Fig. 4). Except for vocalizations, some identifications were based on the sound of wing-clipping, a ‘snort’ or the sound made by vibration of the membrane of the microphone caused by nearby animal movements. The identified animals include: 1) birds: common pigeon (*Columba livia*), collared dove (*Streptopelia decaocto*), common raven (*Corvus corax*), hooded crow (*Corvus cornix*), great tit (*Parus major*), house sparrow (*Passer domesticus*), 2) insects: cicada (probably *Cicada cretensis*), crickets (*Gryllidae* sp.), the moth bird cherry ermine (*Yponomeuta evonymella*) and the endemic to Greece, troglophile cricket *Dolichopoda paraskevii*, 3) bats: Long-fingerd bat (*Miniopterus schreibersii*), Kuhl’s pipistrelle (*Pipistrellus kuhlii*), European free-tailed bat (*Tadarida teniotis*) and 4) a single individual of a larger terrestrial mammal (probably *Mustelid*).

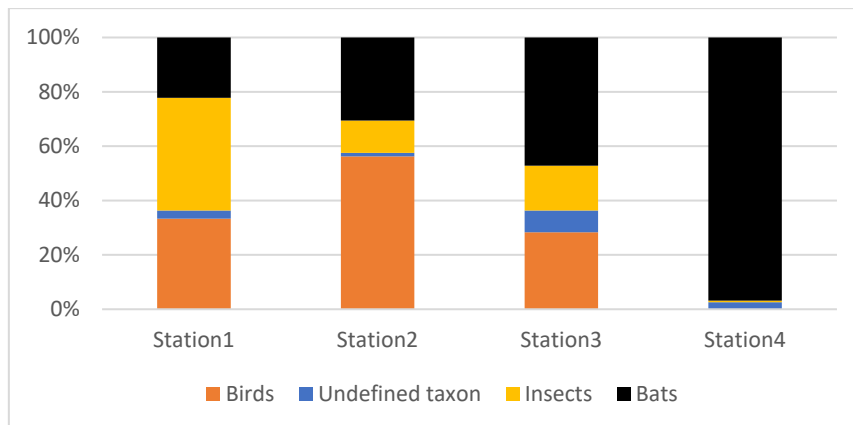


Figure 4. Contribution (%) of animal taxa to biophony, per station

The contribution of audible sounds and ultrasounds to biophony varies significantly among stations (Fig. 5). More than half of total biotic sounds included ultrasound components (grey and black bars). Especially in the dark chamber (Station 4), 333 out of 338 observations consisted exclusively of ultrasounds or a mixture of ultrasounds and audible sounds. Bats were very active in the daytime at Station 4. A lot of bat activity and a few insects were encountered in the ultrasound spectrum. Bats’ ultrasounds consisted of echolocation calls (signals useful for navigation and foraging) of two species: long-fingered bat and Kuhl’s pipistrelle. In contrast, most of their recorded social calls (which are used for interspecific communication) are also perceptible to humans. All bird species, several insects and the European free-tailed bat are within the audible spectrum.

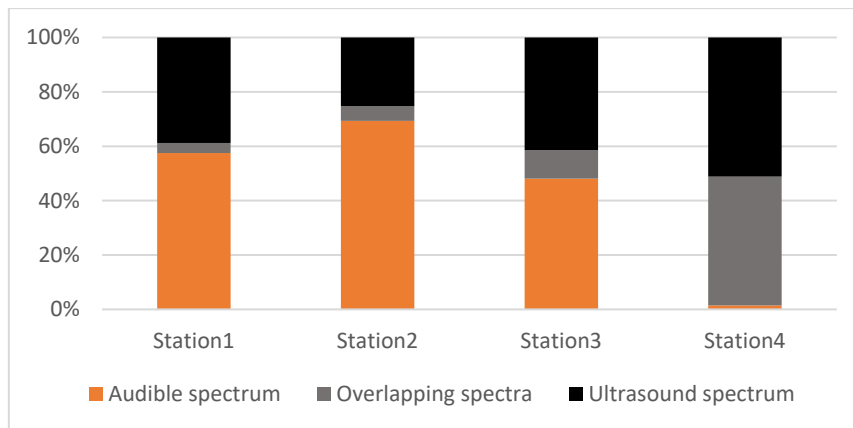


Figure 5. Percentage of biophonic sounds that are within different frequency spectra, per station

3.2.2. Anthropophonic sounds

Acoustic signs of human presence included conversations, whistling, singing, sneezing, footsteps, the sound of crumbling a plastic bottle, electronic devices and vehicles. All the observations, except for one, occurred between 8:00 and 20:00. The time and space span of anthropophony recordings complies with the visual observations from the surveyors. About 90 persons were documented arriving at the doline and entering the cave, but just few of them went further, towards the innermost chamber. During their visit, most of them spent more time at the entrance.

3.2.3. Geophonic sounds

Geophony findings were poor as the only geophysical sound we recorded was the wind.

4. Discussion

4.1. Exploring biophony and re-defining cave soundscape

Soundscape ecologists started, in recent years, to include ultrasound biotic components (Fairbrass et al., 2017). In our study, ultrasounds were instrumental in shaping the subterranean soundscape. Had we not employed full spectrum recorders, we would have forfeited 40% of biophony observations leading to erroneous conclusions on the spatial differentiation of animal activity levels within the cave, particularly in the twilight and dark zones. Ultimately, the most obscure room - the seemingly tranquil one - harbours the most vociferous inhabitants.

Despite the burgeoning field of soundscape ecology, cave soundscapes have yet to be examined from an ecological perspective. This work is the inaugural effort, to our knowledge, to document full spectrum sounds within a cave, meticulously classify them, and assess the importance of each attribute to the cave soundscape, while delineating the cave into several ecozones.

4.2. Efficiency of applied methods in capturing Agia Paraskevi Cave soundscape

The initial endeavour to illustrate the soundscape of Agia Paraskevi Cave yielded promising and substantial preliminary outcomes. The cave's ecozone division is evident in its bioacoustics. The occurrence of particular taxa in designated ecozones correlates with variations in spatial illuminance. The illuminance outlier depicted in Fig. 2 is explicable: a pair of tourists visited the cave during that time and lingered at Station 2, likely utilising a torch. This fact emerged from the recordings. The chosen sound data loggers (AudioMoths) effectively recorded distinct elements of anthropophony and biophony.

4.3. Artefacts of applied methods in capturing Agia Paraskevi Cave soundscape

In determining the optimal parameters for the AudioMoth recordings, our primary concern was to avoid data loss due to low amplitude or sound attenuation. Conversely, we regrettably documented creatures that emit loud sounds at a greater number of sites than first intended. This elucidates the prevalence of insect recordings in the twilight zone: cicadas from the doline were documented concurrently at three sites (Stations 1, 2 and 3). This methodological issue can be resolved by reducing the gain and increasing the amplitude threshold. This artefact is a prevalent issue in bioacoustics, since researchers may inadvertently oversample species, whose vocalisations propagate over extended distances. Ultimately, geophony recordings necessitated superior quality recordings inside the low frequency spectrum.

5. Research recommendations

The investigation and recording of cave soundscapes have commenced, and the aforementioned methodology needs additional revisions and enhancements. The Agia Paraskevi Cave project lacks numerous indicators: data analysis should encompass a larger sample of recordings, and sound collection must occur across various seasons. Furthermore, superior quality data loggers designed for low frequency bandwidth recordings may incorporate geophonic sound events into the soundscape. Upon comprehensive examination of a cave's acoustics, the analysis may be effectively represented through a mapped visualisation.

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Measuring the noise footprint of tourism

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Abstract

The concept of "footprint" in environmental science refers to the resources needed to support a lifestyle, policy, or business strategy, with various methods developed for its calculation. Sound environments and soundscapes are important resources that should be sustainably managed. Environmental noise affects human well-being, health, and productivity, especially in tourist accommodations, which has a substantial noise impact. This research developed a noise footprint calculator for tourist accommodations on Lesbos Island, Greece, identifying main noise sources and using sound level meters for measurements. The composite Soundscape Quality Index (SQI) was designed in order to portray the noise footprint of hotels. Noise maps were created using CadnaA software, and soundscapes were assessed following ISO 12913-1:2014 guidelines. Findings showed seasonal variations in noise footprints, highlighting the need for policies that reduce noise and preserve soundscapes in tourism.

Keywords

Footprint, Tourism, Environmental noise, Soundscape approach

1. Introduction

The concept of a "footprint" in environmental science refers to the resources required to sustain a specific lifestyle, policy, or business strategy (Čuček et al., 2015). Consequently, various methods have been developed to calculate carbon (Shi & Yin, 2021), water (Mekonnen & Gerbens-Leenes, 2020), and energy footprints (Lan et al., 2016). Research shows that sound environments, along with their perceptual dimension, the soundscape, are valuable resources that should be protected and sustainably managed (Aletta & Xiao, 2018). Traditional top-down strategies in noise control, such as legislation and regulations, have not consistently achieved desired outcomes. Instead, it is argued that bottom-up approaches may lead to greater noise reduction and soundscape enhancement. Environmental noise is a hard to solve issue with significant impacts on human well-being,

environmental health and even business productivity. Several tourist accommodations striving for competitiveness and profitability generate noise, leading to a higher noise footprint.

Tourism is a significant global economic sector with a growing environmental footprint, which includes impacts such as noise pollution (Mejjad et al., 2022). Within the tourism industry, accommodations have a notably high energy consumption footprint, contributing to both energy demand and noise generation (Mancini et al., 2018). Initiatives like those from the United Nations World Tourism Organization (UNWTO) have redirected tourism efforts towards biodiversity conservation and energy-efficient practices in hotels, supporting the advancement of sustainable tourism (Blancas et al., 2023). Nature-based solutions in the tourism industry (Han et al., 2020) and the promotion of eco-friendly hotels (Kim & Yun, 2022) have become global imperatives. Sustainable tourism models can be strengthened through the preservation of soundscapes (Bernat, 2014). Both the natural and cultural dimensions of soundscapes are essential components of heritage (Kyvelou et al., 2021) and their protection supports acoustic sustainability. Barry Truax defines acoustic sustainability as *"our ability as a culture to live within a positively functioning soundscape that has long-term viability"* (Truax, 2021). The goal of this research was to develop a noise footprint framework for tourist accommodations in order to reduce their noise impact, establish quieter hotels, improve their soundscape and promote environmental and acoustic sustainability.

Various measures, such as the use of renewable energy in tourist accommodations, are both necessary in response to climate change pressures and attractive for the rising demand in thematic green tourism, or ecotourism (Michalena et al., 2009). Sustainability has emerged as a key selling point for tourist destinations (Glyptou et al., 2022), prompting businesses to develop strategies around sustainable practices. Notably, the motivations behind sustainable and eco-friendly tourism practices often reflect a dual focus: environmental awareness on one side and profitability on the other (Sardianou et al., 2016). Creating a quiet sound environment in tourist areas through noise control can be advantageous but is not always sought after. For example, destinations with specific themes, such as casinos, have a unique ambience where certain noise levels may enhance both customer satisfaction and business profitability (Wendy Gao & Lai, 2015).

In order to establish a positive acoustic environment, soundscape design strategies (Moshona et al., 2024) can be effective. The recent soundscape approach (Mitchell et al., 2020; Papadakis et al., 2023) offers descriptors to capture the perceptual construct of a sound environment, allowing for assessment of a tourist accommodation's soundscape and the identification of potential issues. Thus, while it is essential for hotel owners to reduce unwanted noise sources, it is equally important to craft a positive, environmentally sustainable soundscape. The tourism industry includes interconnected sectors similar to transportation, lodging, and entertainment, that collectively produce significant environmental pressures. Similar to the carbon and water footprints, the noise footprint model captures the pressures tourism activities place on the environment. Hotels, which offer multiple services within tourism, are particularly suited for assessing this noise footprint. Evaluating the acoustic environments and soundscapes of tourist accommodations involves measuring their noise footprint and implementing continuous monitoring to reach a state of "net zero noise." Analogous to the net-zero emissions concept aimed at stabilizing global temperatures through a long-term balance of environmental and social benchmarks (Fankhauser et al., 2022), "net zero noise" strives for acoustic sustainability, aiming towards quiet and harmonious acoustic environments with balanced sound sources. Hotels use various equipment and facilities that generate operational noise, but they also have the potential to offer pleasing soundscapes, fostering both sustainable tourism and acoustic sustainability. This study examines the acoustic environment of common tourist accommodations in Mediterranean island settings. Its primary goal is to assess the noise impact from three resort hotels on Lesbos Island across different seasons. A novel noise footprint composite indicator has been designed and applied in order to evaluate and monitor the soundscape quality of these accommodations.

2. Methodology

The acoustic environment of three resort and apartment-style tourist accommodations was assessed. These hotels (see Figure 1) are situated near the town of Kalloni, a small town in the west-central region of Lesbos Island (North Aegean, Greece). On-site measurements of sound levels, sound recordings, and a sound source inventory were conducted over a three-month period during the summer and autumn of 2022 (August–September–October).



Figure 1. The three hotels in Kalloni (Lesvos)

2.1. Sound source inventory and soundscape assessment

The most common sound sources found in tourist accommodations are classified into four major categories: functional, transportation-related, natural, and recreational sound sources. As shown in Table 1, an inventory list of specific sound-propagating sources has been identified and measured.

Sound source inventory	
Category	Source
Functional	Air-condition units Water pressure valves HVAC systems Garage doors Lawn mowers Pool pumps Sprinklers Kitchen ventilation
Natural	Birds Insects Water
Recreational	Pools Music People
Transportational	Cars Two-wheelers Parking lots

Table 1. Sound source inventory

Noise levels for all sound sources were assessed on-site, using 5-minute samples taken directly facing each source at a height of 1.5 meters above the ground. Data collection was performed with the 01dB Fusion class 1 smart noise monitor and the GRAS 40AE free-field microphone. Prior to sampling, the device was calibrated according to Class 1 standards and the EN61326-1:1997+A1:1998 specifications, using a certified calibrator. The equivalent continuous sound level (L_{eq} , dBA) data were then analyzed using dBTrait v. 6.3.0 software.

Additionally, the soundwalk method was used to apply a soundscape approach for assessing the perceptual construct of the tourist accommodations studied (Oberman et al., 2020). Specifically, a group of five participants, comprising researchers, hotel staff and visitors, evaluated the soundscape of each hotel across different periods. As the research spanned from August to October 2022, the visitor participants varied; however, the total of five

participants remained consistent for each session. Participants used the ISO 12913 recommended questionnaire (ISO 12913, 2014), which included a 5-point Likert scale to rate the perceived affective quality of the eight soundscape descriptors (Pleasant, Chaotic, Vibrant, Uneventful, Calm, Annoying, Eventful, Monotonous). In all cases, the median served as the measure of central tendency.

Background noise levels, primarily from road traffic, were evaluated according to CNOSSOS-EU road traffic noise model guidelines (Kephalopoulos et al., 2012). A manual vehicle counting protocol was implemented to categorize light, medium-heavy, heavy, and two-wheeler vehicles. Furthermore, structural data on the hotels and their surroundings were collected, including urban morphology characteristics, and then visualized in QGIS v. 3.22.1 software. Specifically, the following details were gathered:

- Detailed cartographic representations of buildings, roads, and vegetation in the area of interest
- Building heights and locations
- Vegetation heights and locations
- Road classifications (Motorway, Ordinary Road, Local)
- Road surface types

These data were then integrated into CadnaA noise prediction software to generate noise maps (*CadnaA – State-of-the-Art Noise Prediction Software - Datakustik GmbH, 2024*).

2.2. Assessment of the noise footprint through the composite Soundscape Quality Index (SQI)

To determine the noise footprint of tourist accommodations, a composite indicator known as the Soundscape Quality Index (SQI) was created to incorporate all sound source categories listed in Table 1.

The process began by summing the L_{eq} values within each sound source category, using a logarithmic addition formula (1).

$$L = 10 \log_{10} \left(\sum_{i=1}^n 10^{(L_i/10)} \right) \quad (1)$$

After establishing the total for each category, a Signal-to-Noise Ratio (S/N) approach was applied to integrate the various sound sources. Here, the total values of natural and recreational sound sources were classified as Signals, while functional, transport, and background noise values were classified as Noise.

To allow for comparison and to establish the Soundscape Quality Index (SQI), a normalized difference composite indicator was developed. The SQI was then calculated using the formula below (2):

$$SQI = \frac{Signal - Noise}{Signal + Noise} \quad (2)$$

Where:

- Signal = the summed values of the recreational and natural sound sources
- Noise = the summed values of the transportation, functional and background noise level sound sources

The SQI measures the hotel soundscape on a scale ranging from -1 to +1, with negative SQI values indicating a lower auditory quality.

3. Results and discussion

As shown in Figures 2, noise maps were created to illustrate variations in the noise footprint. The results indicate a gradual seasonal decrease in the noise footprint of the tourist accommodation, which corresponds to a reduction in resident usage of the facilities.

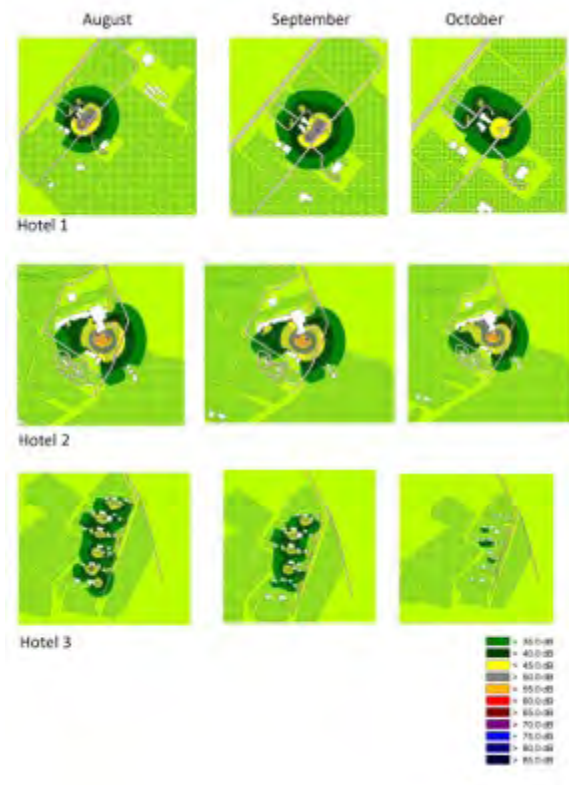


Figure 2. Noise maps for hotel 1, 2 and 3, for August, September and October 2022

In figure 3, the results from the Soundscape Quality Index calculations are presented.

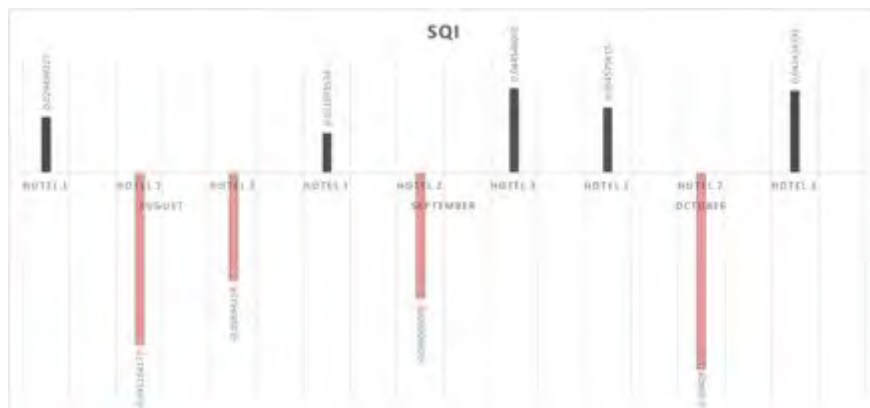


Figure 3. The SQI results for each period and hotel

Hotel 1, being smaller in size, maintains a consistently high Soundscape Quality Index (SQI), which is attributed to its limited size and fewer functional sound sources. In contrast, Hotels 2 and 3 experience fluctuations in their SQI levels, largely due to seasonal variations in tourist occupancy and use of the facilities.

The soundscape assessment that was conducted resulted in several radar plots (circumplex model) showcasing the perceptual tendency of the participants towards the eight soundscape descriptors (Figure 4).

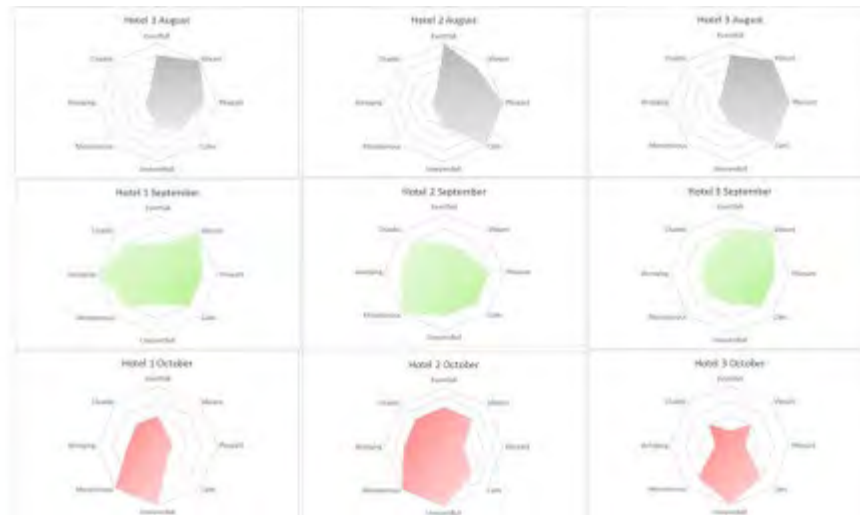


Figure 4. Soundscape assessment of the three hotels during August, September and October 2022

The data reveals seasonal variation in noise footprints and soundscape characteristics across three hotels. Hotel 1 shows a distinct transition from a high-noise, vibrant soundscape in August, reflecting peak visitor activity, to a medium-noise footprint in September where the soundscape retains vibrancy but becomes increasingly perceived as annoying. By October, the noise footprint drops to low, alongside a monotonous and uneventful soundscape, likely indicating a quieter off-season with minimal activity. Hotel 2 presents a unique pattern where its noise footprint remains high in both August and October, despite a notable drop in September. In August, the high-noise environment is associated with an eventful soundscape, while September's medium noise level coincides with a more monotonous soundscape, reflecting a transitional period. Interestingly, October maintains a high noise footprint but lacks activity, resulting in an uneventful auditory environment, potentially due to lingering functional or background noises without active guests. Hotel 3 follows a similar trend to Hotel 1, with a high noise footprint in August and a vibrant soundscape. September sees a decrease to medium noise, characterized by a monotonous soundscape. By October, both the noise footprint and soundscape activity decrease, leading to a quieter, uneventful atmosphere. These variations suggest that soundscapes are strongly influenced by seasonal tourist dynamics, with peak periods bringing vibrant soundscapes, while off-seasons shift toward quieter, less engaging auditory environments.

4. Conclusions

The findings demonstrate a decrease in the noise footprint from August to October, primarily influenced by factors such as hotel size, visitor count, and reduced hotel occupancy. Moreover, the developed Soundscape Quality Index (SQI) effectively captures and highlights the overall sound quality of the hotels, showing improvement as the months progress. Finally, the efforts to balance the SQI index require a series of sound source replacements. More specifically, initiatives to increase natural and recreational sounds result in a positive SQI index and a more pleasurable soundscape, leading to a net-zero noise state. Overall, this study sheds light on the relationship between noise footprint and the soundscape of hotels, emphasizing the significance of promoting acoustic sustainability.

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A watercolor illustration of a dark bird perched on a branch, with the title text overlaid.

Soundscape analysis and Digital Preservation

Οι Ήχοι του Τελευταίου Παραδοσιακού Φανοποιείου της Σκοπέλου

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Περίληψη

Η παραδοσιακή τέχνη της φανοποιείας, ένα από τα αρχαιότερα επαγγέλματα, βρίσκεται πλέον στα πρόθυρα της εξαφάνισης. Αυτή η ερευνητική εργασία εστιάζει στην καταγραφή, αποτύπωση και ανάδειξη των ήχων του τελευταίου παραδοσιακού εργαστηρίου φανοποιείας της Σκοπέλου, στις Σποράδες, για τη δημιουργία ενός ηχητικού ντοκιμαντέρ (podcast) που παρουσιάζει το επάγγελμα και την εξέλιξη της φανοποιείας στο πέρασ των χρόνων. Το αφηγηματικό πλαίσιο υλοποιείται μέσα από τη λεπτομερή εξιστόρηση του Γιώργου Λιθαδιώτη, του τελευταίου φανοποιού του νησιού. Η αφήγηση εμβαθύνει στον κοινωνικο-πολιτιστικό ιστό της Σκοπέλου, παρουσιάζοντας γεγονότα της καθημερινής ζωής που εκτείνονται από τα τελευταία χρόνια του 19^{ου} αιώνα έως τη σύγχρονη εποχή.

Για την τεκμηρίωση του ηχητικού ντοκιμαντέρ κρίθηκε απαραίτητο η δημιουργία μιας ηχητικής βιβλιοθήκης, η οποία περιλαμβάνει ηχητικά δείγματα από τη διαδικασία κατασκευής τεσσάρων βασικών εργαλείων που συνδέονται με το επάγγελμα του φανοποιού. Επίσης, για την ηχητική επένδυση του ντοκιμαντέρ πραγματοποιήθηκε καταγραφή 12 διαφορετικών ηχοτοπίων της Σκοπέλου όπως το παλιό λιμάνι, το εργαστήριο φανοποιείας, τα σοκάκια της χώρας, παραλίες κ.λπ. τα οποία χρησιμοποιήθηκαν ως ηχητικό υπόβαθρο στο ηχητικό ντοκιμαντέρ. Η συνέντευξη του κ. Λιθαδιώτη καταγράφηκε στη Χώρα της Σκοπέλου και συγκεκριμένα στην αυλή ενός παραδοσιακού σπιτιού.

Λέξεις Κλειδιά

Ηχοτοπίο, φανοποιείο, ηχητικό ντοκιμαντέρ, βιβλιοθήκη ήχων, καταγραφή πεδίου, Σκόπελος

1. Εισαγωγή

Η παραδοσιακή λαϊκή τέχνη της φανοποιείας ή αλλιώς λευκοσιδηρουργίας, ένα από τα αρχαιότερα επαγγέλματα συνυφασμένο με την ανθρώπινη εξέλιξη, βρίσκεται πλέον στα πρόθυρα της εξαφάνισης. Η τεχνολογική πρόοδος, ο σύγχρονος τρόπος ζωής, η έλλειψη επαγγελματικής διαδοχής με ταυτόχρονη απώλεια μεταφοράς της τεχνογνωσίας από τους παλαιότερους τεχνίτες, συντελούν στη σταδιακή εξαφάνιση ενός παραδοσιακού επαγγέλματος συνυφασμένο με την καθημερινότητα των ανθρώπων στις μικρές κοινωνίες.

Οι Τενεζοποιοί, γνωστοί και ως «φαναρτζήδες» ή «τενεκετζήδες», παρήγαγαν ένα ευρύ φάσμα καθημερινών ειδών οικιακής χρήσης μέσω της σχολαστικής επεξεργασίας του σιδήρου. Η τέχνη αυτή, η οποία άνθισε σε όλη την ελληνική επικράτεια, αφορούσε τη δημιουργία και την επισκευή μεταλλικών αντικειμένων για οικιακή χρήση. Συνδυάζοντας την τεχνική ικανότητα διαμόρφωσης του λευκοσιδήρου (λαμαρίνα) με έμφαση τόσο στην αισθητική όσο και στη λειτουργικότητα, οι φανοποιοί κατασκεύαζαν μια μεγάλη γκάμα ειδών που περιλάμβαναν, μπρίκια και δίσκους σεβριρίσματος για τον ελληνικό καφέ, ποτιστήρια, μικρές στάμνες μέχρι και μεγάλα δοχεία σχεδιασμένα για τη μεταφορά του νερού, λαδιού ή γάλακτος. Πριν από την ευρεία υιοθέτηση του ηλεκτρισμού, κατασκεύαζαν φανάρια για οικιακό φωτισμό καθώς και φανούς για τη σήμανση σε άμαξες, πλοία, εκκλησίες και δρόμους. Επιπλέον, οι συγκεκριμένοι τεχνίτες επέδειξαν αξιοσημείωτη ικανότητα στη

δημιουργία μοναδικών αντικειμένων, εμποτισμένων με σημαντική συμβολική αξία για τα τοπικά έθιμα. Παραδείγματα περιλαμβάνουν τα φανάρια του γάμου και η περίτεχνα σχεδιασμένη στεφανοθήκη.

2. Μελέτη περίπτωσης

Η συγκεκριμένη έρευνα αφορά την καταγραφή των ήχων του τελευταίου παραδοσιακού φανοποιείου της Σκοπέλου, στις Σποράδες, για τη δημιουργία ενός ηχητικού ντοκιμαντέρ (podcast) που παρουσιάζει το επάγγελμα και την εξέλιξη της φανοποιείας στο πέρασ των χρόνων, μέσα από την εξιστόρηση γεγονότων από τον τελευταίο φανοποιό του νησιού, τον Γιώργο Λιθαδιώτη. Η εξιστόρηση εστιάζει στο νησί της Σκοπέλου, περιλαμβάνει ιστορίες και γεγονότα της καθημερινής ζωής, από το πρώτο εργαστήριο που είχε φτιάξει ο παππούς του στις αρχές του 20^{ου} αιώνα, μέχρι και τις ημέρες μας.

3. Δημιουργία ηχητικής βιβλιοθήκης

Για την τεκμηρίωση του ηχητικού ντοκιμαντέρ κρίθηκε επιβεβλημένη η δημιουργία και η χρήση μιας ηχητικής βιβλιοθήκης που περιλάμβανε ηχητικά δείγματα από τη διαδικασία κατασκευής τεσσάρων αντικειμένων άρρηκτα συνδεδεμένων με το επάγγελμα της φανοποιείας όπως η στεφανοθήκη, η υδρορροή, ο δίσκος σερβιρίσματος και το μπρίκι. Για κάθε αντικείμενο καταγράφηκαν οι επιμέρους διαδικασίες κατασκευής του, οι οποίες περιλάμβαναν την επεξεργασία ετερογενών υλικών με τη χρήση εξειδικευμένων εργαλείων, οδηγώντας στη δημιουργία ποικίλων ηχητικών δειγμάτων. Η εν λόγω βιβλιοθήκη συνιστά μια ιστορική τεκμηρίωση της τέχνης της φανοποιείας, καθώς για πρώτη φορά, οι διάφορες διεργασίες κατασκευής αποτυπώθηκαν με εξοπλισμό υψηλής ποιότητας και εξαιρετικής ακρίβειας.

Συγκεκριμένα, καταγράφηκαν οι ηχογόνες πηγές, οι ήχοι του φανοποιού αλλά και το ηχοτοπίο του εργαστηρίου κατά τη διαδικασία της κατασκευής. Ταυτόχρονα, έγινε εφικτό να καταγραφεί η χρήση εργαλείων χειρός, τα οποία έχουν πλέον αντικατασταθεί από ηλεκτρικά και δεν χρησιμοποιούνται στις ημέρες μας. Τα ηχητικά δείγματα της βιβλιοθήκης καταγράφηκαν με τρόπο ώστε να μην είναι ηχητικά απομονωμένα από το περιβάλλον τους, καθώς έμφαση δόθηκε στο να ενταχθεί και να αναδειχθεί το ηχοτοπίο του εργαστηρίου. Κύριος στόχος της καταγραφής ήταν η διάσωση των ήχων του τελευταίου παραδοσιακού φανοποιείου — ήχων που σύντομα θα εκλείψουν. Για τον λόγο αυτό, τα ηχητικά δείγματα που παρατίθενται, καθώς και εκείνα που αξιοποιήθηκαν στο ηχητικό ντοκιμαντέρ, υπέστησαν ελάχιστη ηχητική επεξεργασία, ώστε να αποτυπωθεί πλήρως η ηχητική τους ταυτότητα.

3.1. Διαδικασία ηχογράφησης και επεξεργασίας

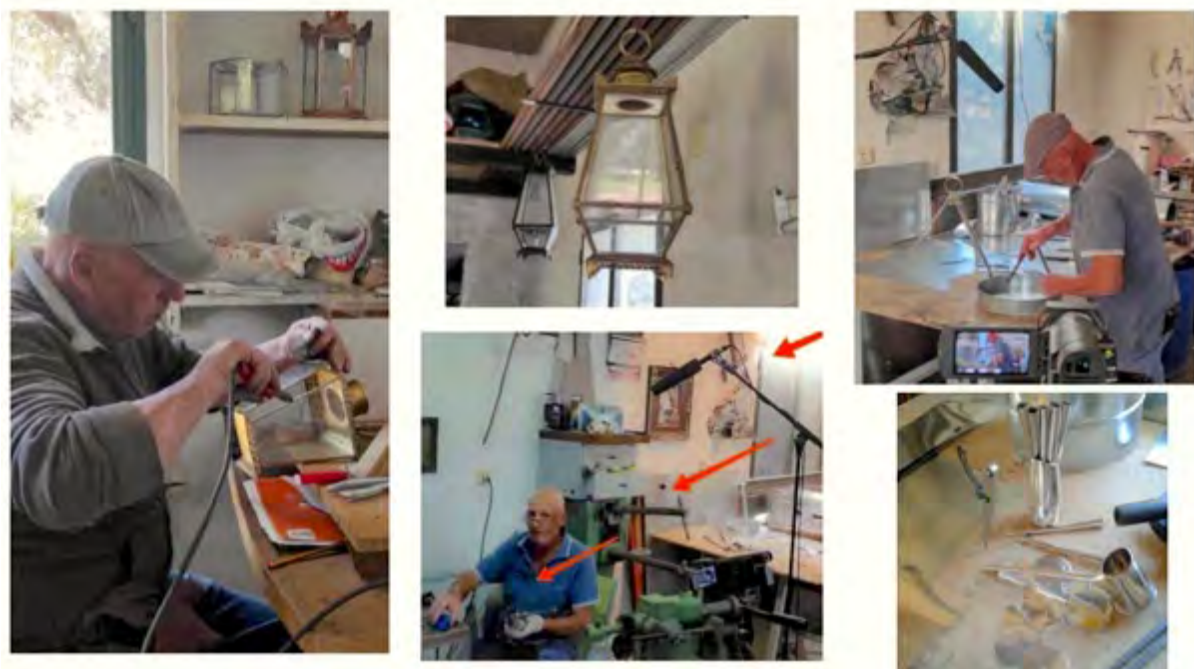
Η καταγραφή των ήχων του εργαστηρίου πραγματοποιήθηκε με την ηχογράφιση της διαδικασίας κατασκευής τεσσάρων μεταλλικών αντικειμένων. Οι κατασκευές που καταγράφηκαν ήταν μία υδρορροή, ένα μπρίκι, ένας δίσκος και μία στεφανοθήκη, στις οποίες χρησιμοποιήθηκαν το σύνολο των εργαλείων του φανοποιείου. Είναι σημαντικό να σημειωθεί ότι η διαδικασία συλλογής των ηχητικών δειγμάτων του εργαστηρίου προσέδωσε μια αυθεντική χροιά στις ηχογραφήσεις, καθώς τα εργαλεία δεν χρησιμοποιήθηκαν τυπικά για την παραγωγή ηχητικών δειγμάτων, όπως γίνεται συνήθως στις ηχητικές βιβλιοθήκες, αλλά για την πραγματική δημιουργία των μεταλλικών κατασκευών.

Χρησιμοποιήθηκαν τρία πυκνωτικά μικρόφωνα, δύο μικρόφωνα πέτου (lavalier) (Shure WL185) και ένα ιδιαίτερος κατευθυντικό μικρόφωνο τύπου shotgun (AKG C568). Η τοποθέτηση των μικροφώνων στο εργαστήριο πραγματοποιήθηκε με σκοπό την καταγραφή των κτυπογενών δονήσεων και των ήχων που παράγονται κατά τη χρήση εργαλείων, όπως χαρακτηριστικά φαίνεται στην Εικόνα 1. Το πρώτο μικρόφωνο πέτου τοποθετήθηκε στο βασικό πάγκο εργασίας στον οποίο πραγματοποιούνταν οι κατασκευές και χρησιμοποιήθηκε ως μικρόφωνο επαφής για την καταγραφή των δονήσεων που προκαλούνται από τα χτυπήματα των εργαλείων, αλλά και για την ηχογράφιση των ήχων από σχετική απόσταση. Το δεύτερο μικρόφωνο, το οποίο ήταν τοποθετημένο στο στήθος του φανοποιού, λειτουργούσε ως τυπικό μικρόφωνο πέτου, επιτρέποντας την καταγραφή όχι μόνο των ήχων των εργαλείων κατά τη χρήση τους αλλά και των αναπνοών και των χαρακτηριστικών εκφράσεων του φανοποιού. Τέλος, το κατευθυντικό μικρόφωνο τοποθετήθηκε σε βάση, επιτρέποντας την κίνησή του στο χώρο και τη στόχευση στα εργαλεία που χρησιμοποιούσε ο φανοποιός. Η ηχογράφιση από σχετική απόσταση με το κατευθυντικό μικρόφωνο

αποδείχθηκε η πλέον αξιοποιήσιμη, παρέχοντας ολοκληρωμένες καταγραφές των εργαλείων, απορρίπτοντας ταυτόχρονα ανεπιθύμητους πλαϊνούς θορύβους του εργαστηρίου.

Συνολικά, η παραπάνω τοποθέτηση των μικροφώνων εξασφάλισε την απαιτούμενη ελευθερία κινήσεων του φανοποιού και ταυτόχρονα παρείχε τη δυνατότητα αξιοποίησης του πρωτογενούς υλικού για παραγωγή διαφορετικών ηχητικών δειγμάτων από την ίδια ηχητική πηγή. Για την εύρεση των επιμέρους σημείων τοποθέτησης των μικροφώνων κάθε κατασκευής απαιτήθηκαν πολλές δοκιμές, κυρίως για τον προσδιορισμό της κατάλληλης ευαισθησίας (gain) του καταγραφικού.

Η επεξεργασία που εφαρμόστηκε στις ηχογραφήσεις ήταν ήπια και τυπική, καθώς εξ αρχής δόθηκε ιδιαίτερη έμφαση στη βέλτιστη καταγραφή των μεταλλικών κατασκευών, προκειμένου να είναι κατάλληλες για τη χρήση τους στη βιβλιοθήκη. Εφαρμόστηκε ισοστάθμιση για μείωση των χαμηλών συχνοτήτων (High Pass Filter: 40 Hz, 24 dB/oct) καθώς το φάσμα κάτω από τα 40 Hz δεν περιείχε χρήσιμο και αξιοποιήσιμο ηχητικό υλικό. Επίσης, η συμπίεση της δυναμικής περιοχής αποφεύχθηκε, επιτρέποντας στις ηχογραφήσεις να διατηρήσουν ευρύ δυναμικό εύρος, γεγονός που ενισχύει την αυθεντικότητα και την πιστότητα του καταγεγραμμένου υλικού.



Εικόνα 1. Κατασκευή παραδοσιακού φαναριού (αριστερή φωτογραφία). Τα φανάρια του γάμου (πάνω μεσαία). Τοποθέτηση των μικροφώνων στο εργαστήριο φανοποιείας (κάτω μεσαία). Η καταγραφή της κατασκευής του δίσκου (πάνω δεξιά). Τα μέρη του μπρικιού στον πάγκο εργασίας (κάτω δεξιά)

3.1.1. Η στεφανοθήκη

Η στεφανοθήκη, συνήθως περίτεχνα σχεδιασμένη και τοποθετημένη σε περίοπτη θέση σε κάθε σκοπελίτικο σπίτι, αποτελείται από ένα μεταλλικό κουτί με λεπτά τζαμάκια, στην οποία τοποθετούνται και φυλάσσονται τα «στέφανα» του γάμου¹⁶. Αξίζει να αναφερθεί ότι με παρόμοιο τρόπο κατασκευάζονταν τα φανάρια του γάμου, φαναράκια που χρησιμοποιούνται ακόμα στις ημέρες μας για το στολισμό της εκκλησίας κατά το μυστήριο του γάμου. Όπως χαρακτηριστικά αναφέρει κ. Λιθαδιώτης στο ηχητικό ντοκιμαντέρ, τα φανάρια του γάμου προέρχονται από μια παλαιά συνήθεια της σκοπελίτικης κοινωνίας. Τα παλαιά χρόνια οπού γινόταν η διαδικασία του προξενιού¹⁷, συνήθως ο γαμπρός πήγαινε με τους γονείς του στο σπίτι της νύφης με αναμμένο

¹⁶ Τα στέφανα του γάμου είναι δύο συμβολικά στεφάνια που τοποθετούνται στα κεφάλια των νεόνυμφων κατά την ορθόδοξη τελετή του γάμου.

¹⁷ Το προξενίο αποτελεί μια παραδοσιακή διαδικασία εύρεσης κατάλληλου συντρόφου με σκοπό το γάμο, την οποία συνήθως αναλάμβαναν άτομα από το στενό περιβάλλον των δύο ατόμων. Ήταν ιδιαίτερα διαδεδομένο στο παρελθόν σε διάφορες κοινωνίες και πολιτισμούς.

ένα φανάρι του γάμου. Εάν το προξενικό «πετύχαινε», έφευγαν από το σπίτι με αναμμένο το φανάρι, ενώ εάν δεν πετύχαινε το προξενικό έφευγαν με σβηστό φανάρι¹⁸.

3.1.2. Η υδρορροή

Η υδρορροή αποτελείται από έναν μεταλλικό σωλήνα, ο οποίος τοποθετείται στην περιφέρεια των κεραμοσκεπών με σκοπό τη συγκέντρωση του νερού της βροχής σε ένα σημείο. Τα παλαιότερα χρόνια, το νερό αυτό κατέληγε σε κάποιο πηγάδι ή στέρνα ώστε να μπορεί να αξιοποιηθεί από τους κατοίκους του σπιτιού. Σήμερα, στις σύγχρονες κατοικίες συνήθως το νερό της υδρορροής διοχετεύεται απευθείας στα αυλάκια που βρίσκονται στους δρόμους και ο σκοπός της τοποθέτησής της είναι η πρόληψη της συσσώρευσης νερού στις εξωτερικές αυλές. Η κατασκευή αυτή αποτελεί ένα από τα βασικά αντικείμενα κατασκευής του φανοποιείου, εφόσον είναι ακόμη απαραίτητη για τη συντήρηση των σπιτιών και για την αποτελεσματική διαχείριση των νερών της Σκοπέλου¹⁹.

3.1.3. Ο δίσκος σερβιρίσματος

Ο δίσκος σερβιρίσματος έχει τρία ισοζύγια, δηλαδή τρία κομμάτια μετάλλου που ενώνουν το χερούλι με τον πάτο του δίσκου, σχηματίζοντας έτσι ένα κώνο. Με τη συγκεκριμένη επεξεργασία επιτυγχάνεται στιβαρότητα και αρκετή ισορροπία στο αντικείμενο που μεταφέρεται με τον δίσκο. «Ο παραδοσιακός δίσκος είναι για μεγάλες αποστάσεις» όπως αναφέρει χαρακτηριστικά ο κ. Λιθαδιώτης, «γιατί τα καφενεία σέρβιραν τον καφέ τους στα τραπέζια που είχαν απέναντι από το δρόμο ή ακόμη και σε όλα τα μαγαζιά της γειτονιάς». Στη σημερινή εποχή, ακόμη κάποιες καφετέριες στη Σκόπελο έχουν τέτοιους δίσκους είτε για πρακτικούς είτε για αισθητικούς λόγους²⁰.

3.1.4. Το μπρίκι

Το παραδοσιακό μπρίκι του ελληνικού καφέ έχει μακριά λαβή, η οποία χρησιμεύει στο ψήσιμο του καφέ στη χόβολη²¹, ώστε να μην υπερθερμαίνεται και να πραγματοποιείται εύκολα η διαδικασία του βρασμού (Εικόνα 1). Παλαιότερα, κάθε καφενείο διέθετε χόβολη με την οποία παρασκεύαζαν τον ελληνικό καφέ και χρησιμοποιούσαν παραδοσιακά μπρίκια από χαλκό ή ορείχαλκο²².

4. Καταγραφή ηχοτοπίων

Για την ηχητική επένδυση του ντοκιμαντέρ πραγματοποιήθηκε καταγραφή 12 διαφορετικών ηχοτοπίων της Σκοπέλου, τα οποία χρησιμοποιήθηκαν είτε ως εφέ ηχητικού υποβάθρου (background effects) είτε ως σκληρά εφέ (hard effects), δηλαδή ηχητικά εφέ που αφορούν συγκεκριμένους ήχους και αποδίδουν ενέργειες ή καταστάσεις οι οποίες σχετίζονται με την εξιστόρηση του κ. Λιθαδιώτη (Viers, 2008: 32).

Τα ηχοτοπία καταγράφηκαν χρησιμοποιώντας τη στερεοφωνική τεχνική M/S (Mid/Side), η οποία θεωρείται από τις πλέον διαδεδομένες μεθόδους ηχογράφησης ηχοτοπίων. Στην εν λόγω τεχνική, το μικρόφωνο Mid διαθέτει πανκατευθυντικό (omnidirectional) πολικό διάγραμμα και είναι τοποθετημένο με τρόπο ώστε να στοχεύει προς το κέντρο της περιοχής που καταγράφεται, ενώ το μικρόφωνο Side, το οποίο έχει δικατευθυντικό (figure of 8) πολικό διάγραμμα, τοποθετείται κάθετα σε σχέση με το κέντρο του ηχοτοπίου, σε γωνία 90° off axis (Dooley & Streicher, 1982, 715-716). Η τεχνική M/S προσφέρει ποικίλα πλεονεκτήματα, καθιστώντας την ιδανική για την

¹⁸ Δημιουργήθηκαν τα εξής ηχητικά δείγματα: Κολώνες τζαμιών, Κολώνες τζαμιών με ματσόλα, Τρίψιμο με λίμα.

¹⁹ Δημιουργήθηκαν τα εξής ηχητικά δείγματα: Χάραξη με διαβήτη, Κόψιμο σωλήνα, Κόψιμο απορροής, Κύλινδρος, Κύλινδρος – ματσόλα και αμόνι, Κορδονιέρα, Στραντζάρισμα απορροής με ξύλινο σφυρί πάνω στο αμόνι, Ένωση της στράντζας (με σφυρί και καλέμι), Χτύπημα απορροής - μεταλλικό σφυρί πάνω σε αμόνι. Το στραντζάρισμα είναι η διαδικασία διαμόρφωσης της απορροής για να ενωθούν καλύτερα οι άκρες του μετάλλου.

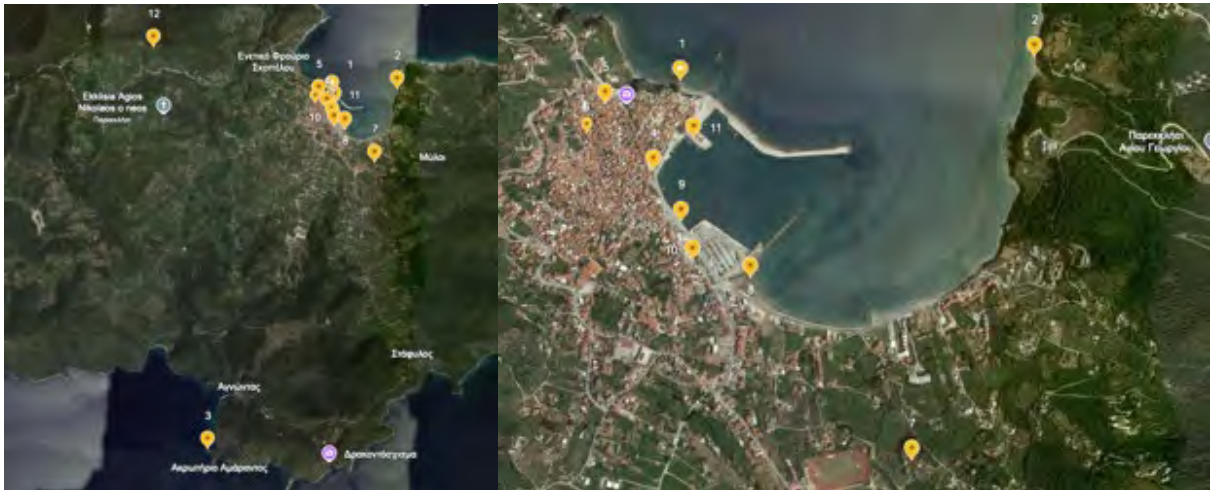
²⁰ Δημιουργήθηκαν τα εξής ηχητικά δείγματα: Ήχος Ψαλιδιού, Στραντζάρισμα με μεταλλικό σφυρί στο αμόνι, Δράπανο, Ηλεκτρικό δράπανο χειρός, Ηλεκτροπόντα, Ένωση πάτου με τα τοιχώματα.

²¹ Ένα είδος στάχτης από ξυλοκάrbουνα που χρησιμοποιείται για το ψήσιμο του παραδοσιακού ελληνικού καφέ. Συνηθίζεται να τοποθετείται άμμος πάνω στη σταχτή, προκειμένου να διατηρηθεί η θερμοκρασία της στάχτης. Με αυτόν τον τρόπο, ο καφές σιγοψήνεται με αποτέλεσμα να είναι πιο γευστικός.

²² Δημιουργήθηκαν τα εξής ηχητικά δείγματα: Κόλληση πάτου, Κόλληση λαβής, Μεταλλική μπικόρνα, Ξύλινη μπικόρνα-ματσόλα, Στραντζάρισμα με ματσόλα, Χτύπημα λαβής στο αμόνι.

καταγραφή ηχοτοπίων. Ειδικότερα, επιτυγχάνει ομοιομορφία στην απόδοση του ηχητικού πεδίου και στην αισθητική της ακρόασης ενώ παρέχει ευδιάκριτο και καθαρό εντοπισμό των ηχητικών πηγών (localization). Επιπλέον, η εφαρμογή και ο χειρισμός της τεχνικής κατά την ηχογράφιση στο πεδίο είναι απλή και ευέλικτη, γεγονός που διευκολύνει τη διαδικασία καταγραφής. Τέλος, η τεχνική M/S προσφέρει σημαντική ευελιξία κατά το στάδιο της μεταπαραγωγής, επιτρέποντας στον ηχολήπτη να προσαρμόσει τη στερεοφωνική εικόνα με ακρίβεια και λεπτομέρεια (Μαραγκός κ.ά., 2016).

Τα ηχοτοπία χωρίστηκαν σε τρεις κατηγορίες. Η πρώτη κατηγορία ηχοτοπίων περιλαμβάνει την ηχογράφιση χαρακτηριστικών ηχοτοπίων της Σκοπέλου. Συγκεκριμένα, καταγράφηκαν τέσσερις παραλίες του νησιού: οι Πλάκες, η Άμμος, μια βοτσαλωτή παραλία κοντά στο βουνό Παλούκι, και το ακρωτήρι Αμάραντος, όπως απεικονίζονται στην Εικόνα 2. Στην παραλία Πλάκες (σημείο 1), καταγράφηκε η βοή των κυμάτων καθώς προσέκρουαν στα βότσαλα, δημιουργώντας τον ήχο μιας φθινοπωρινής, φουρτουνιασμένης θάλασσας του Σεπτεμβρίου. Το ηχοτοπίο αυτό χρησιμοποιήθηκε για να νοηματοδοτήσει το χώρο (νησί) και την εποχή (φθινόπωρο) όπου το ηχητικό ντοκιμαντέρ τοποθετείται. Αντιθέτως, στην παραλία Άμμος (σημείο 8), ηχογραφήθηκαν παιδικές φωνές που χρησιμοποιήθηκαν ως ένα φανταστικό ηχοτοπίο, στο οποίο κυριαρχούν τα παιδιά τα οποία έπαιζαν με τα μεταλλικά παιχνίδια που κατασκεύαζαν οι παλιοί φανοποιοί. Επιπλέον, το ηχοτοπίο της βοτσαλωτής παραλίας (σημείο 2) χρησιμοποιήθηκε ως ηχητικό υπόβαθρο στο ντοκιμαντέρ, όταν ο κ. Λιθαδιώτης αναφέρεται στη δημιουργία μιας μικρογραφίας του μυθολογικού πλοίου του Ιάσωνα, της Αργούς. Τέλος, στο ακρωτήρι Αμάραντος (σημείο 3), καταγράφηκε ο ήχος της θάλασσας, που ανέβαινε και κατέβαινε απαλά στο ύψος των βράχων, προσομοιάζοντας τον ήχο των βαρκών με ελαφρά ανατάραξη σε ένα ήσυχο λιμάνι. Αυτό το ηχοτοπίο συνοδεύει στο ντοκιμαντέρ τις αναφορές στους ψαράδες, προσδίδοντας αίσθηση αυθεντικότητας και σύνδεση με τον ναυτικό παρελθόν της περιοχής.



Εικόνα 2. Αποτύπωση των σημείων καταγραφής της Σκοπέλου μέσω google maps

Η δεύτερη κατηγορία αποτελούνταν από ηχοτοπία με ιδιαίτερες ηχογόνες πηγές, πηγές που εξαιτίας του υπερτουρισμού και της αστικοποίησης τείνουν σιγά-σιγά να σιγήσουν (Εικόνα 3). Συγκεκριμένα, ηχογραφήθηκε ο καλπασμός του φορτωμένου μουλαριού που αγκομαχάει στα σοκάκια, μεταφέροντας βαρύ φορτίο και χτυπώντας με δύναμη τα πέταλά του διεγείροντας χαρακτηριστικά το αντηχητικό πεδίο της Χώρας. Το ηχοτοπίο αυτό συνόδευε την εξιστόρηση του κ. Λιθαδιώτη στο σημείο που αναφέρεται στον τρόπο με τον οποίο ο παππούς του, ο κ. Κανάρης, μετέφερε τις μεταλλικές κατασκευές του με το γαϊδουράκι του στα χωριά Κλίμα και Γλώσσα της Σκοπέλου. Επιπλέον, ηχογραφήθηκε το λιμάνι της Σκοπέλου και συγκεκριμένα στην προβλήτα, στο σημείο που ο ψαράς μέσα από το καΐκι του προσπαθεί να εμπορευτεί την ψαριά του. Το ηχοτοπίο αυτό προστέθηκε ως ηχητικό υπόβαθρο στο ντοκιμαντέρ όταν ο κ. Λιθαδιώτης αναφέρεται στα μεταλλικά αντικείμενα που κατασκεύαζε για τους ψαράδες. Τέλος, ηχογραφήθηκε το ξωκλήσι του Αη-Γιώργη κατά τη διάρκεια της Θείας Λειτουργίας, όπου οι ήχοι των ψαλμωδιών αναμειγνύονται με το κροτάλισμα της αναμμένης στη φύση φωτιάς, έθιμο που πραγματοποιείται μόνο μία φορά τον χρόνο. Το συγκεκριμένο ηχοτοπίο χρησιμοποιήθηκε ως ηχητικό υπόβαθρο στο ντοκιμαντέρ, στο σημείο όπου ο κ. Λιθαδιώτης αναφέρεται στην κατασκευή εκκλησιαστικών ειδών, όπως το καντήλι, που δημιουργούσε κατά περιόδους. Η προσθήκη αυτή ενισχύει την ατμόσφαιρα της αφήγησης, εναρμονίζοντας τους ήχους των ψαλμωδιών με τη φωτιά και την αφήγηση.



Εικόνα 3. Ο ψαράς στο λιμάνι (αριστερή φωτογραφία). Ο Αγωγιάτης με το μουλάρι του (πάνω μεσαία). Ο εξωτερικός χώρος του εργαστηρίου (κάτω μεσαία). Ηχογράφηση στο σπίτι του κ. Λιθαδιώτη (πάνω δεξιά). Ηχογράφηση στη τοποθεσία Πλάκες (κάτω δεξιά)

Η τρίτη κατηγορία εμπεριέχει ηχοτοπία που αναδύουν τους ήχους της Χώρας αλλά και ιδιαίτερων τοπόσημων της Σκοπέλου. Συγκεκριμένα, ηχογραφήθηκαν τρία σημεία στην ευρύτερη περιοχή του λιμανιού της Σκοπέλου: α) ο πλάτανος στην πλατεία (σημείο 4) όπου ακούγονται τα φύλλα που πέφτουν στο δρόμο. Το θρόισμα των φύλλων και ο ήχος τους καθώς πέφτουν από τον πλάτανο σηματοδοτεί κατά κάποιο τρόπο την αλλαγή της εποχής και στο ηχητικό ντοκιμαντέρ λειτουργεί ως συμβολική μετάβαση στα χρόνια που έζησε ο παππούς του κ. Λιθαδιώτη. β) ο χτύπος της καμπάνας σε εκκλησία της Χώρας (σημείο 10) και γ) ένα χαρακτηριστικό σημείο στο παλιό λιμάνι της Σκοπέλου (σημείο 11), όπου αποτυπώθηκαν οι πρωινοί ήχοι της φύσης, όπως το κελάηδισμα των πουλιών και οι φωνές των γλάρων. Στο ντοκιμαντέρ ο κ. Λιθαδιώτης αναφέρει ότι στο παρελθόν πολλοί κάτοικοι εγκατέλειπαν τη Σκόπελο λόγω έλλειψης ευκαιριών εργασίας. Οι συγκεκριμένες καταγραφές, με τους «μοναχικούς» ήχους της φύσης στο λιμάνι, αντανακλούν την εικόνα του παλιού λιμανιού, στο οποίο δεν υπάρχει έντονη ανθρώπινη δραστηριότητα, προσδίδοντας μια ατμόσφαιρα νοσταλγίας και αποξένωσης. Επιπλέον, καταγράφηκε το ηχοτοπίο της αυλής της οικίας του κ. Λιθαδιώτη (σημείο 6), όπου συλλέχθηκαν ήχοι όπως η κόρνα των καραβιών που έρχονταν στο λιμάνι, ήχοι από ψαλμωδίες της κοντινής εκκλησίας, τιτβίσματα πουλιών αλλά και ομιλίες ντόπιων. Οι παραπάνω ήχοι χρησιμοποιήθηκαν κυρίως ως σκληρά εφέ, σε συγκεκριμένα σημεία, για να εμπλουτίσουν το ηχητικό υπόβαθρο της αυλής. Τέλος, καταγράφηκε η αυλή του εργαστηρίου φανοποιείας (σημείο 7), στην οποία διακρίνονται το κελάηδημα πτηνών και το λάλημα ενός πετεινού. Ο συγκεκριμένος ήχος ενσωματώθηκε στο ηχητικό ντοκιμαντέρ με συμβολική λειτουργία ως προοίμιο, καθώς το λάλημα του πετεινού, κατά παράδοση, σηματοδοτεί την έναρξη της νέας ημέρας. Με αυτόν τον τρόπο η εισαγωγή αποσκοπεί να προϊδεάσει τον ακροατή για την έναρξη μιας αφήγησης που, ενώ αντλεί από το ιστορικό παρελθόν, παρακινεί σε μια νέα ακουστική εμπειρία.

5. Δημιουργία ηχητικού ντοκιμαντέρ

Η συνέντευξη με τον κ. Λιθαδιώτη πραγματοποιήθηκε σε έναν οικείο χώρο, στην αυλή της κατοικίας του στη Χώρα της Σκοπέλου, επιδιώκοντας μια ειλικρινή και αυθόρμητη συζήτηση. Το ηχητικό περιβάλλον της συνέντευξης διαμορφώθηκε από τους ήχους της καμπάνας του χωριού, τις συνομιλίες των συγχωριανών του και τις κόρνες των πλοίων κατά την είσοδό τους στο λιμάνι, δημιουργώντας ένα χαρακτηριστικό ηχητικό υπόβαθρο. Οι ήχοι αυτοί συνέβαλαν στην αίσθηση οικειότητας και αυθεντικότητας, ενισχύοντας την εντύπωση μιας φιλικής συζήτησης, σαν αυτή που θα μπορούσε να λάβει χώρα πίνοντας χαλαρό καφέ σε μια αυλή μεταξύ του κ. Λιθαδιώτη και του ακροατή.

Η αφηγηματική δεξιότητα του κ. Λιθαδιώτη και η ευχέρεια λόγου με τη χαρακτηριστική σκοπελίτικη προφορά του, αποτέλεσαν ιδανικό υλικό για τη δημιουργία του ηχητικού ντοκιμαντέρ. Η σε βάθος ανάλυση των θεμάτων που θίγει, συμπεριλαμβανομένων των αναμνήσεων για τους παππούδες του και της τέχνης της φανοποιείας, προσέφερε πολύτιμες πληροφορίες και προσέδωσε επιπλέον ιστορικό και πολιτισμικό πλαίσιο αναδεικνύοντας στοιχεία της τοπικής ταυτότητας, της λαϊκής παράδοσης και της προφορικής πολιτισμικής κληρονομιάς. Οι αφηγήσεις του χαρακτηρίζονται από έντονο περιγραφικό ενδιαφέρον, επιτρέποντας την ανάπτυξη ηχητικών στοιχείων καθώς και τη διαμόρφωση ηχητικών εικόνων. Η συνέντευξη εμπλουτίστηκε με ήχους από το εργαστήριο φανοποιείας καθώς και με ηχοτοπία της Σκοπέλου, όπως αναλύθηκαν παραπάνω, συνθέτοντας ένα ολοκληρωμένο ηχητικό έργο που ενισχύει την ακουστική εμπειρία και αναδεικνύει τη σύνδεση του αφηγητή τόσο με τον τόπο του όσο και με την τέχνη της φανοποιείας.

Η χρήση του αφηγηματικού συνδέσμου²³ κρίθηκε απαραίτητη για τη διασφάλιση της συνοχής και της ομαλής μετάβασης μεταξύ των θεματικών ενότητων στο ηχητικό ντοκιμαντέρ. Ο εν λόγω σύνδεσμος επιλέχθηκε να είναι τριτοπρόσωπος, ακολουθώντας τους κανόνες ραδιοφωνικής αφήγησης που προτείνει ο Tim Crook (1999) στο έργο του για το ραδιοφωνικό θέατρο. Στο πλαίσιο αυτό, οι αφηγηματικοί σύνδεσμοι λειτουργούν ως συνδετικοί κρίκοι των επιμέρους αποσπασμάτων της συνέντευξης, ενισχύοντας την αφηγηματική συνέχεια του ντοκιμαντέρ χωρίς να επαναλαμβάνουν ή να προοικονομούν τα λεγόμενα του αφηγητή. Αντ' αυτού, επικεντρώνονται στην ανάδειξη των συναισθημάτων, των σκέψεων και των πληροφοριών σχετικά με το χρόνο και τον τόπο διεξαγωγής των συμβάντων που περιγράφονται, εμπλουτίζοντας με αυτό τον τρόπο την ακουστική εμπειρία (Crook, 1999: 215).

Η χρονική διάρκεια του αφηγηματικού συνδέσμου διατηρήθηκε μικρή (έως 45 δευτερόλεπτα) προκειμένου να εξυπηρετεί την αναγκαία συνοχή, χωρίς να αποσπά από την αφήγηση του κ. Λιθαδιώτη. Η δημιουργία των συνδέσμων έγινε με σκοπό να αποδοθεί ένα δραματοποιημένο και ελαφρώς ποιητικό ύφος, το οποίο να προσδίδει επιπλέον βάθος στο σενάριο του ηχητικού ντοκιμαντέρ. Οι φράσεις της αφήγησης επιλέχθηκαν προσεχτικά, δόθηκε ιδιαίτερη βαρύτητα στη σωστή άρθρωση και τον ρυθμό, διατηρώντας πάντα ισορροπία με τα ηχοτοπία και την αφήγηση του. Η συγκεκριμένη προσέγγιση επέτρεψε την ομαλή εισαγωγή των θεμάτων προς συζήτηση, ενσωματώνοντας αναπαραστάσεις εικόνων και παραθέτοντας ταυτόχρονα ερωτήματα που εμπλουτίζουν την πλοκή. Με τον τρόπο αυτό ενισχύθηκε η εμπειρία του ακροατή και προάχθηκε η συνοχή του ντοκιμαντέρ.

Το ηχητικό ντοκιμαντέρ περιλαμβάνει δύο παραδοσιακά σκοπελίτικα τραγούδια από τη μουσικολογική έκδοση «Κατακαημένη Σκόπελε...»²⁴, τα οποία λειτουργούν ως αφηγηματικοί σύνδεσμοι. Τα τραγούδια σηματοδοτούν την έναρξη νέων σκηνών και μεταφέρουν στον ακροατή τα μουσικά ακούσματα της εποχής που περιγράφει ο κ. Λιθαδιώτης. Το πρώτο τραγούδι, με τίτλο «Γαμπρέ τη νύφη ν' αγαπάς» (αριθ. 12 στον δίσκο της έκδοσης), επιλέχθηκε για την έναρξη της αφήγησης του κ. Λιθαδιώτη. Η τοποθέτηση του τραγουδιού σε αυτό το σημείο υποδηλώνει τη μετάβαση στον εσωτερικό χώρο του εργαστηρίου, όπου ο αφηγητής περιγράφει την κατασκευή μιας στεφανοθήκης και αναφέρεται στη χρήση του φαναριού στους γάμους κατά το παρελθόν (η εξιστόρηση έχει γίνει την ώρα που κατασκευάζει τη στεφανοθήκη). Έτσι, το συγκεκριμένο τραγούδι γάμου δημιουργεί ένα ηχητικό έναυσμα για την ιστορία που ξετυλίγεται στο εργαστήριο του φανοποιού, ενισχύοντας κατά κάποιο τρόπο τη σύνδεση του ντοκιμαντέρ με τις παραδόσεις του τόπου.

Το δεύτερο τραγούδι που ενσωματώθηκε στο ηχητικό ντοκιμαντέρ είναι το «Χίλια καλώς ορίσατε» (αριθ. 11 στον δίσκο). Το τραγούδι επιλέχθηκε για να καλωσορίσει τον ακροατή στην αυλή του σπιτιού του κ. Λιθαδιώτη, προσκαλώντας τον να αφουγκραστεί την αφήγηση του γύρω από το επάγγελμα του φανοποιού, σε ένα ζεστό και οικείο περιβάλλον. Οι στίχοι του τραγουδιού αποκαλούν τον επισκέπτη «κανάρι», μια φράση που συνδέεται με την αφήγηση, καθώς ο κ. Λιθαδιώτης αναφέρεται στη συνέχεια στον παππού του, τον Κωνσταντίνο Κανάρη Λιθαδιώτη, τον πρώτο φανοποιό της Σκοπέλου. Με αυτόν τον τρόπο, το τραγούδι, μέσω των στίχων του, προοικονομεί την έναρξη της διήγησης για τον πρόγονο του αφηγητή, προσφέροντας παράλληλα μια συμβολική εισαγωγή στο επάγγελμα και στην οικογενειακή παράδοση.

Η δομή του ντοκιμαντέρ διαμορφώθηκε σύμφωνα με τις αρχές του ραδιοφωνικού ντοκιμαντέρ, όπως περιγράφονται στο έργο του Tim Crook (1999: 215-216)²⁵. Σε αυτό το πλαίσιο, η έναρξη περιλαμβάνει τον ήχο

²³ Η δημιουργία του κειμένου και η αφήγησης έγινε από τη Ναταλία Λιθαδιώτη, κόρη του κ. Λιθαδιώτη.

²⁴ Βλ. Κατακαημένη Σκόπελε ...

²⁵ Σύμφωνα με τον Tim Crook, η αποτελεσματική δομή ενός ηχητικού ντοκιμαντέρ βασίζεται σε μια δυναμική εισαγωγή που δημιουργεί προσδοκίες, σε μια ισορροπία μεταξύ εισαγωγής και κατάληξης, στη χρήση επαναλήψεων που ενισχύουν τη μνήμη και τη συνοχή, στην επιδίωξη αφηγηματικού συνδέσμου μέσω λογικής ανάπτυξης ερωτημάτων και απαντήσεων, καθώς και στην εναλλαγή της διάρκειας των συνδετικών στοιχείων, η οποία συμβάλλει καθοριστικά στη ρυθμική ποικιλία και, τελικά, στην ενίσχυση της ακουστικής εμπειρίας.

της θάλασσας και τον ήχο του σφυριού πάνω στο αμόνι, ο οποίος σταδιακά καλύπτει τους ήχους της φύσης, συνοδευόμενος από ένα παραδοσιακό γαμήλιο τραγούδι. Αυτή η σύνθεση εισάγει τον ακροατή με έναν πρωτότυπο και υποσχόμενο τρόπο, δημιουργώντας αναμονή για τη συνέχεια. Η προσθήκη δημιουργικών ηχοτοπίων, ο αφηγηματικός σύνδεσμος και η εναλλαγή του χώρου συνέντευξης ενισχύουν την εμπειρία του ακροατή, καθελώνοντάς τον στην αφήγηση του φανοποιού και αναδεικνύοντας τη σημασία της τέχνης του. Το ευρηματικό κλείσιμο με την ερώτηση του αφηγηματικού συνδέσμου προς τον ακροατή, «*Ποιος άραγε θα χτυπήσει το σφυράκι στο μέταλλο, ώστε να παράξει αυτούς τους ήχους; Μήπως, κλείνοντας μια μέρα την πόρτα, ο κυρ Γιώργης μαζί με την τέχνη του χαθούν και οι ήχοι αυτού του επαγγέλματος μια για πάντα;*» ολοκληρώνει τη δομή του ηχητικού ντοκιμαντέρ με έντονο συναισθηματικό τρόπο. Έτσι, ο εμπλουτισμός της συνέντευξης του κ. Λιθαδιώτη με τα προαναφερόμενα στοιχεία ανέδειξε την αυθεντικότητα των λόγων του και συνέβαλε αποφασιστικά στη διαμόρφωση ενός καλά δομημένου ηχητικού ντοκιμαντέρ. Ο τίτλος του τελικού ηχητικού ντοκιμαντέρ είναι «Η Ιστορία της Φανοποιείας»²⁶, με διάρκεια 26 λεπτά και 26 δευτερόλεπτα.

6. Διάχυση του έργου

Η διάχυση του έργου, περιλάμβανε τη διοργάνωση μιας ημερίδας με τίτλο: «Η Ιστορία της Φανοποιείας στη Σκόπελο»²⁷ που πραγματοποιήθηκε στη Σκόπελο στις 17.06.2023 προς τιμήν του τελευταίου φανοποιού της Σκοπέλου τον κ. Λιθαδιώτη. Η ημερίδα περιλάμβανε έκθεση με παραδοσιακά αντικείμενα κατασκευασμένα από τον κ. Λιθαδιώτη ενώ ο κόσμος είχε τη δυνατότητα να περιεργαστεί παραδοσιακά εργαλεία και αντικείμενα, και ταυτόχρονα να ακούσει τα ηχητικά δείγματα της βιβλιοθήκης. Επίσης, παρουσιάστηκε ολόκληρο το ηχητικό ντοκιμαντέρ.

Τέλος, το ηχητικό ντοκιμαντέρ συμμετείχε στο 64^ο Διεθνές Φεστιβάλ Κινηματογράφου Θεσσαλονίκης στο διαγωνιστικό τμήμα των podcast²⁸.

7. Αναφορές

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The Sound of the Last Traditional Tinsmith of Skopelos

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Abstract

Traditional tinsmithing, one of the most ancient professions, is now on the verge of disappearing. This research project focuses on capturing the sounds of the last traditional tinsmith workshop in Skopelos, Greece. The goal is to produce a sound documentary (podcast) that both elucidates the craft and chronicles the historical trajectory of tinsmithing. The narrative framework is constructed through the detailed recounting of Giorgos Lithadiotis, the island's last practicing tinsmith. The storytelling delves into the socio-cultural fabric of Skopelos, presenting anecdotes and everyday life events that span from the last years of 19th century to contemporary times.

For the completion of the sound documentary, it was deemed essential to create a sound library that included audio samples from the process of constructing four essential gears linked to the tinsmithing profession: the wedding crown case, the gutter, the serving tray, and the coffee pot. Mr. Lithadiotis' interview was recorded in the town of Skopelos, specifically in the courtyard of a traditional house.

For the sound design of the documentary, recordings were made of 12 different soundscapes of Skopelos, including the old port, the tinsmith workshop, the town's narrow streets, beaches, and more. These soundscapes were used as the audio background for the documentary.

Keywords

Field recording, soundscape, traditional tinsmith, sound documentary, sound library, Skopelos

Ηχοδιαδρομές και προστατευόμενες περιοχές – Η περίπτωση μελέτης του Εθνικού Θαλάσσιου Πάρκου Ζακύνθου

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Περίληψη

Οι Προστατευόμενες Περιοχές (ΠΠ) είναι εθνικά πάρκα και καταφύγια άγριας ζωής, στα οποία το νομικό πλαίσιο καθορίζει κανόνες για την προστασία και τη διαχείριση. Η συμβίωση ανθρώπων και φύσης αποτελεί κρίσιμο στόχο για την αειφόρο ανάπτυξη. Οι ΠΠ είναι πεδία για επιστημονική μελέτη και διδασκαλία σχετικά με τις οικολογικές διαδικασίες, τη διατήρηση ειδών και οικοσυστημάτων. Η Ακουστική Οικολογία (ΑΟ) αναφέρεται στην αλληλεπίδραση των ήχων στο περιβάλλον και αναπτύσσει την ακουστική αντίληψη, ώστε οι άνθρωποι να μπορούν να καλλιεργήσουν μια κατανόηση του ακουστικού περιβάλλοντος και να αποκτήσουν μια ολοκληρωμένη εμπειρία.

Οι φοιτητές εκπονούν αυτήν την έρευνα στο πλαίσιο του μαθήματος ΑΟ του Τμήματος Περιβάλλοντος του Ιονίου Πανεπιστημίου, με στόχο τη δημιουργία επικοινωνιακού υλικού για τις ΠΠ, τα οικοσυστήματα και τη βιοποικιλότητά τους. Στο πλαίσιο αυτής της έρευνας, μελέτη περίπτωσης στην οποία ήταν το Εθνικό Θαλάσσιο Πάρκο της Ζακύνθου, έχει δημιουργηθεί ένας χάρτης και δύο διαδρομές, ενώ έχουν συγκεντρωθεί περιγραφές και αφηγήσεις. Οι ηχογραφήσεις των ηχοτοπίων πραγματοποιήθηκαν χρησιμοποιώντας εξοπλισμό υψηλής πιστότητας, τηρώντας τις αρχές και τις μεθοδολογίες της ΑΟ. Η έρευνα εστιάζει στην εξέταση των χωρικών παραλλαγών του ηχοτοπίου μέσα σε φυσικά οικοσυστήματα. Έχει πραγματοποιηθεί απογραφή της βιοποικιλότητας, των μορφών γης και των οικοσυστημάτων που βρίσκονται σε κάθε σημείο.

Λέξεις-κλειδιά

Ηχοδιαδρομές, ηχοτοπία, Προστατευόμενες Περιοχές, Ακουστική Οικολογία, Εθνικό Θαλάσσιο Πάρκο Ζακύνθου

1. Εισαγωγή

Η Ακουστική Οικολογία (ΑΟ) ασχολείται με τη μελέτη του ήχου, ως συστατικό του περιβάλλοντος. Η συνειδητοποίηση του ήχου -και συγκεκριμένα το επίπεδο συνειδητοποίησης του ακουστικού περιβάλλοντος σε κάθε δεδομένη στιγμή- είναι ένα ζήτημα που αποτελεί κεντρικό θέμα της διεπιστημονικής Ακουστικής

Οικολογίας (επίσης γνωστή ως Οικοακουστική). Ειδικότερα μελετά τη δομή, τα χαρακτηριστικά και τη δυναμική του ακουστικού περιβάλλοντος, τη συσχέτιση του με το φυσικό περιβάλλον και την επίδρασή του στη συμπεριφορά των οργανισμών, των ανθρώπων και των κοινωνιών. Το ακουστικό περιβάλλον διαμορφώνεται από ήχους ανθρώπινης, βιολογικής και γεωφυσικής προέλευσης, οι οποίοι συνυπάρχουν (Wrightson et al., 2000).

Η παρούσα έρευνα, διεξήχθη από φοιτητές του προπτυχιακού προγράμματος σπουδών του Τμήματος Περιβάλλοντος του Ιονίου Πανεπιστημίου και πραγματοποιήθηκε στο πλαίσιο του μαθήματος Ακουστικής Οικολογίας. Κύριος στόχος της έρευνας είναι να αναδείξει τη δυνατότητα της Ακουστικής Οικολογίας, να εμπλουτίσει τη διεπιστημονικότητα της περιβαλλοντικής εκπαίδευσης και παράλληλα να υποστηρίξει τη διατήρηση, προστασία και ανάδειξη σημαντικών περιβαλλοντικών περιοχών. Πρόκειται για μία δράση πεδίου, η μεθοδολογία της οποίας περιλαμβάνει τη λήψη συντεταγμένων σε κάθε σημείο, χαρτογράφηση των διαδρομών, ηχογραφήσεων, χρήσης πρωτοκόλλου για την καταγραφή και κατηγοριοποίηση των ήχων, περιγραφή των σημείων, λήψης φωτογραφικού υλικού, συμπλήρωσης πρωτοκόλλου για την υφιστάμενη βιοποικιλότητα, επεξεργασία του υλικού και δημιουργία υλικού προβολής (αφηγήματα).

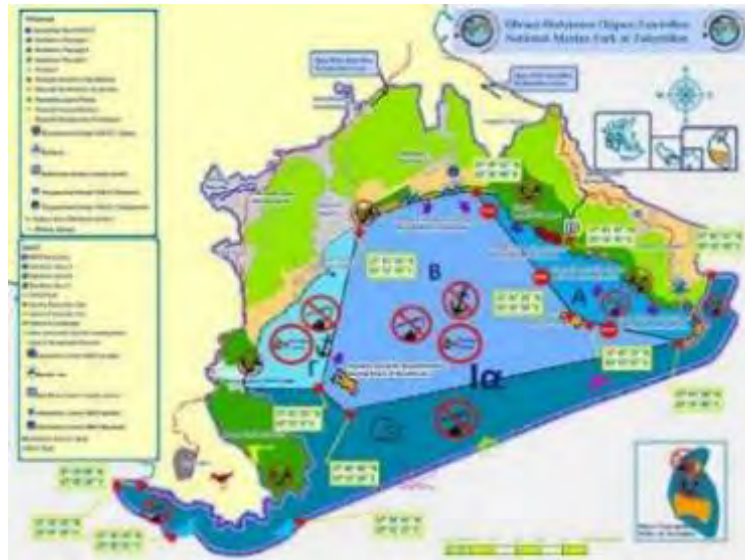
Ως περιοχή μελέτης της παρούσας έρευνας έχει επιλεγεί η Προστατευόμενη Περιοχή (ΠΠ) του Εθνικού Θαλάσσιου Πάρκου Ζακύνθου και ειδικότερα δύο από τις παραλίες ωτοκίας της ΠΠ, το Καλαμάκι και ο Γέρακας. Και οι δύο παραλίες φιλοξενούν σημαντικό αριθμό φωλιών ενώ παράλληλα προσφέρουν τις οικοσυστημικές τους υπηρεσίες ως τουριστικός προορισμός στους επισκέπτες κατά την καλοκαιρινή περίοδο.

Το Εθνικό Θαλάσσιο Πάρκο Ζακύνθου (ΕΘΠΖ), ιδρύθηκε στις 22 Δεκεμβρίου 1999. Το 2000 δημιουργήθηκε ο Φορέας Διαχείρισης Προστατευόμενης Περιοχής (ΦΔΠΠ) του Πάρκου, ο οποίος ανέλαβε την ευθύνη για τη διαχείριση και τον σχεδιασμό του (Togridou et al., 2006). Βρίσκεται στο νοτιοανατολικό τμήμα της Ζακύνθου και περιλαμβάνει τον κόλπο του Λαγανά, τα νησιά Στροφάδες, τις νησίδες Πελούζο και Μαραθονήσι, καθώς και τη χερσαία περιοχή των δήμων Ζακυνθίων και Λαγανά. Το Πάρκο στοχεύει στην προστασία της φυσικής κληρονομιάς του κόλπου του Λαγανά και των νησιών Στροφάδες. Η θαλάσσια έκταση του Πάρκου είναι 89.2 εκτάρια και η χερσαία έκταση 45.4 εκτάρια. Βάσει του υφιστάμενου θεσμικού πλαισίου έχει ως πρωταρχικό στόχο την προστασία των σημαντικότερων παραλιών ωτοκίας των χελωνών καρέτα-καρέτα (*Caretta-caretta*) στη Μεσόγειο. (Theocharous et al., 2011)

Επιπλέον, στο Ε.Θ.Π.Ζ. περιλαμβάνονται σημαντικοί βιότοποι της μεσογειακής φώκιας *Monachus-monachus*, της μεταναστευτικής ορνιθοπανίδας, της ενδημικής χλωρίδας καθώς και οικότοποι ευρωπαϊκού και μεσογειακού ενδιαφέροντος όπως τα συστήματα αμμοθινών και αλόφιλης βλάστησης και τα υποθαλάσσια λιβάδια του φυτού *Posidonia-oceanica*.

Όσον αφορά στις θαλάσσιες ΠΠ, εκπληρώνουν τρεις βασικές λειτουργίες: α) τη διατήρηση της θαλάσσιας βιοποικιλότητας, β) τη διατήρηση της οικολογικής παραγωγικότητας και γ) τη βιώσιμη συμβολή στην οικονομική και κοινωνική ευημερία του τοπικού πληθυσμού.

Γενικότερα, οι ΠΠ και τα εθνικά πάρκα αποτελούν προνομιακές περιοχές για τουρισμό με βάση τη φύση, συμπεριλαμβανομένου του οικοτουρισμού (Ceballos-Lascurain et al., 1996). Παράλληλα όμως, η τουριστική δραστηριότητα στα εθνικά πάρκα και στις ΠΠ αποτελεί πρόκληση για τη σύνδεση ανθρώπου και φύσης. Οι επιπτώσεις της τουριστικής δραστηριότητας στο περιβάλλον είναι άμεσες και είναι κατά περίπτωση θετικές ή/και αρνητικές. Η ζήτηση και η προσφορά είναι οι δύο λειτουργίες του τουρισμού, που συχνά αντιπαράτιθενται στο φυσικό περιβάλλον (Theocharous et al., 2011).



Εικόνα 1. Απεικόνιση των ζωνών του Θαλάσσιου Πάρκου Ζακύνθου

2. Μεθοδολογία

Η έρευνα περιλαμβάνει δράσεις πεδίου, καταγραφές καθώς και επεξεργασία των δεδομένων. Έτσι, σε κάθε περιοχή μελέτης, Γέρακας και Καλαμάκι, επιλέχθηκαν σημεία με ιδιαίτερο ενδιαφέρον όσον αφορά στην ηχητική ποικιλότητα, στη διαφορετικότητα των οικοσυστημάτων και στην βιοποικιλότητα τους. Έτσι, το πρώτο στάδιο της έρευνας αποτέλεσε η επιλογή των κατάλληλων σημείων, ώστε να καλύπτεται γεωγραφικά η περιοχή μελέτης και η λήψη συντεταγμένων, όπου χρησιμοποιήθηκε το mobile GPS Garmin ETREX 22x. Η μορφή των συντεταγμένων ήταν σε υπόβαθρο WGS 84 και το αρχείο αποθηκεύτηκε σε μορφή .gpx. Για την εξασφάλιση υψηλής ακρίβειας στη χαρτογράφηση χρησιμοποιήθηκε το λογισμικό ArcGIS Pro.



Εικόνα 2. Χαρτογράφηση των σημείων καταγραφής στην περιοχή Γέρακας (αριστερά) και καλαμάκι (δεξιά)

2.1. Τα σημεία καταγραφής

Ανάλογα με την περιοχή, επιλέχθηκαν σημεία που θεωρήθηκαν αντιπροσωπευτικά τόσο του τοπίου όσο και των ηχητικών χαρακτηριστικών της. Κοινό στοιχείο στην επιλογή ήταν η εγγύτητα στο κύριο μονοπάτι του ηχοπερίπατου που δημιουργήθηκε και η εύκολη προσβασιμότητα. Ειδικότερα, η επιλογή των σημείων δε βασίστηκε σε σταθερά κριτήρια, βάσει πρωτοκόλλου, αλλά καθορίστηκε από τη διαφοροποίηση των οικοσυστημάτων, τη βιοποικιλότητα που παρατηρήθηκε μακροσκοπικά και την εναλλαγή ζωνών, περιορισμών εντός της ΠΠ κ.ά. Λόγω της ιδιαίτερης περιβαλλοντικής ταυτότητας της ΠΠ η επιλογή περιελάμβανε καταγραφές στο χερσαίο τμήμα, στην αμμοθινική ζώνη, στην ακτή/θάλασσα, σε ιδιαίτερους γεωλογικούς σχηματισμούς, σε παράκτιο δάσος.

Ειδικότερα, στο Καλαμάκι επιλέχθηκαν 5 σημεία, ακολουθώντας το προκαθορισμένο μονοπάτι και επιλέγοντας ως πρώτο σημείο, εκείνο που βρίσκεται πιο κοντά στο οδικό δίκτυο. Με κατεύθυνση προς την παραλία συνεχίστηκε η καταγραφή σε σημεία εναλλαγής οικοσυστημάτων, βιοποικιλότητας και ανθρώπινων δραστηριοτήτων ώπου να ολοκληρωθεί η ηχοδιαδρομή στην ακτή. Στην περιοχή του Γέρακα επιλέχθηκαν 6 σημεία, αρχίζοντας από τον χώρο στάθμευσης και την ξύλινη είσοδο, καλύπτοντας την ακτογραμμή και προσεγγίζοντας τους γεωλογικούς σχηματισμούς.

2.2. Κατηγοριοποίηση ήχων και ηχογραφήσεις

Η ηχητική ποικιλότητα σε μία ΠΠ δύναται να ερευνηθεί σε βάθος μέσω της κατηγοριοποίησης των ήχων που καταγράφονται. Η ακριβής κατηγοριοποίηση είναι ιδιαίτερα σημαντική για την ανάλυση του ηχοτοπίου και την κατανόηση των διαφόρων ηχητικών επιδράσεων στο περιβάλλον όπως οι ήχοι της βιοποικιλότητας, οι ήχοι ανθρωπογενούς προέλευσης, οι μηχανικοί ήχοι κ.ά. Η συμπλήρωση καθορισμένου πρωτοκόλλου, προκειμένου να διακριθούν οι ήχοι σε φυσικούς και ανθρωπογενείς καθώς και σε προσκηνίου και υποβάθρου προσδίδει μία δυναμική στο να αποτυπωθούν τα ιδιαίτερα ηχητικά χαρακτηριστικά σε μία ΠΠ.

Οι ηχογραφήσεις των ηχοτοπίων πραγματοποιήθηκαν με τη χρήση ηχητικού εξοπλισμού υψηλής πιστότητας, τηρώντας τις μεθοδολογίες καταγραφής που έχουν αναπτυχθεί όλα αυτά τα χρόνια στις ηχογραφήσεις πεδίου και ηχοτοπίων (Μαραγκός κ.ά., 2016, Μνιέστρης κ.ά., 2006, Λουφόπουλος κ.ά., 2012). Οι ηχογραφήσεις επικεντρώθηκαν κυρίως στην ακριβή αποτύπωση του ηχοτοπίου στα σημεία ενδιαφέροντος, με προσπάθεια αποφυγής των ήχων ανθρωπογενούς προέλευσης, ιδιαίτερα εκείνων που προέρχονταν από τουρίστες και τις δραστηριότητές τους. Έμφαση δόθηκε στην αποτύπωση των χωρικών διακυμάνσεων/αλλαγών του ηχοτοπίου μέσα σε αυτά τα μοναδικά οικοσυστήματα που καταγράφηκαν. Συγκεκριμένα, χρησιμοποιήθηκε μια τρισδιάστατη τεχνική ηχογράφησης, γνωστή ως Ambisonics, χρησιμοποιώντας το μικρόφωνο Ambeo VR Mic της Sennheiser²⁹, εξοπλισμένο με ειδικό αντιανεμικό θώρακα και τη σχετική ανεμοπροστασία³⁰ για αποφυγή παραμόρφωσης στα διαφράγματα του μικροφώνου. Το συγκεκριμένο μικροφωνικό σύστημα αποτελείται από τέσσερις διακριτές καρδιοειδείς κάψες KE 14 σε τετραεδρική διάταξη, ενσωματωμένες σε ένα ενιαίο συμπαγές σώμα, ευέλικτο και εύκολο στη χρήση, ιδανικό για καταγραφές πεδίου. Ταυτόχρονα, στην πλειονότητα των σημείων ενδιαφέροντος εφαρμόστηκε η στερεοφωνική τεχνική ζεύγους (spaced pair A-B) με τα μικρόφωνα Clippy EM272 (omni) σε μεταξύ τους απόσταση περίπου 30 cm. Αυτή η προσέγγιση επιλέχθηκε για να δημιουργήσει μια πιο ευρεία στερεοφωνική εικόνα σε σχέση με την Ambisonics, ενισχύοντας με αυτό τον τρόπο την αντίληψη των χωρικών διαστάσεων και του βάθους στις ηχογραφήσεις (Huber & Runstein, 2013, 139). Λόγω του μικρού μεγέθους των μικροφώνων, της βάσης και του καταγραφικού, κατά τη μετακίνηση από το ένα σημείο ενδιαφέροντος στο επόμενο, η συγκεκριμένη τεχνική αξιοποιήθηκε εκπαιδευτικά για την εξοικείωση των φοιτητών/τριων στην επαυξημένη ακρόαση μέσω ακουστικών και στη σωστή χρήση του καταγραφικού.

Οι ηχογραφήσεις του Ambeo καταγράφηκαν στον ψηφιακό φορητό εγγραφέα της Sound Devices MixPre-6 και της στερεοφωνικής τεχνικής A-B στο ZOOM F3. Όλα τα ηχητικά αρχεία ήταν τύπου *wav με συχνότητα δειγματοληψίας 96 kHz και ανάλυση 24 bit για το MixPre-6 και 32 bit για το ZOOM F3, για την επίτευξη καλύτερης ποιότητας ήχου. Οι ηχογραφήσεις που προέρχονταν από το Ambeo αποκωδικοποιήθηκαν στο Reaper Digital Audio Workstation από A φορμά σε B φορμά *Classic FuMa* με χρήση του αλγόριθμου *Ambeo A-B Converter Plugin* που συνοδεύει το μικρόφωνο, μαζί με το απαραίτητο φίλτρο για βελτίωση της συχνотικής απόκρισης του μικροφώνου. Έπειτα, οι ηχογραφήσεις αποκωδικοποιήθηκαν σε στέρεο φορμά με τη χρήση του *JS ATK FOA Decode Stereo* για τις ανάγκες αυτής της έρευνας. Η επεξεργασία που υπέστησαν οι ηχογραφήσεις ήταν ήπια καθώς βασική προτεραιότητα ήταν η απόδοση της ρεαλιστικότητας του ηχοτοπίου. Για αυτό το λόγο

²⁹Βλ. *Εγχειρίδιο χρήσης Ambeo VR Mic*.

³⁰BBG Windshield και BBG Windjammer της εταιρίας Rycote.

εφαρμόστηκε ισοστάθμιση για μείωση των χαμηλών συχνοτήτων (High Pass Filter: 40 Hz, 24 dB/oct) διότι, όπως προέκυψε από τις ακροάσεις, το φάσμα κάτω από τα 40 Hz δεν περιείχε χρήσιμο και αξιοποιήσιμο ηχητικό υλικό.



Εικόνα 3. Διαδικασία ηχητικής καταγραφής και συμπλήρωσης πρωτοκόλλου

2.3. Βιοποικιλότητα και χαρακτηριστικά του τοπίου

Για τη δημιουργία μιας ολιστικής προσέγγισης του τοπίου που τίθεται προς μελέτη κρίθηκε απαραίτητη η αποτύπωση της βιοποικιλότητας, μέσω της αναγνώρισης των ειδών πανίδας και χλωρίδας που απαντώνται σε κάθε σημείο. Η καταγραφή της ορνιθοπανίδας εκτός από την οπτική παρατήρηση επιτεύχθηκε και μέσω της αναγνώρισης των ηχητικών τους καλεσμάτων από την εφαρμογή Merlin ID. Σημειώθηκαν επίσης, δεδομένα όπως γεωγραφικά χαρακτηριστικά, η χρονική στιγμή της καταγραφής, οι καιρικές συνθήκες που επικρατούσαν, τα είδη των οικοσυστημάτων που βρίσκονταν στα σημεία ηχοληψίας και οι ανθρωπογενείς παρεμβάσεις, όπως μονοπάτια, κτίρια ή άλλες δομές. Επιπλέον, καταγράφηκαν τα γεωλογικά φαινόμενα που συναντώνται, ειδικότερα στην παραλία του Γέρακα που το αργιλώδες ανάγλυφο δημιουργεί γεωλογικούς σχηματισμούς σπάνιου φυσικού κάλλους.

Συνολικά αναγνωρίστηκαν 13 είδη ασπόνδυλων, μεταξύ των οποίων η μεσογειακή σαρανταποδαρούσα (*scolopendra-cingulate*) και το σαλιγκάρι των αμμοθινών (*theba-pisana*). Εντοπίστηκαν επίσης 6 είδη φυτών, όπως ο κοινός βάτος (*rubus-fruticosus*), ο ασφόδελος (*asphodelus-ramosus*), το κρινάκι της θάλασσας (*pancratium-maritimum*) και η εντυπωσιακή ορχιδέα του είδους *ophrys-tenthredinifera*. Στην κατηγορία των πτηνών καταγράφηκαν 4 είδη, συμπεριλαμβανομένου του κότσυφα (*turdus-merula*) και του αξιαγάπητου "φλώρου" (*chloris-chloris*). Επιπρόσθετα, καταγράφηκαν 4 είδη ερπετών και αμφιβίων, όπως ο πράσινος φρύνος (*bufotes-iridis*) και η ιόνιος σαύρα (*rodarcis-ionicus*).

Όλα τα προαναφερθέντα είδη τεκμηριώνονται με φωτογραφικό υλικό και συνδυάζονται με την ηχητική ταυτότητα της περιοχής, όπως καταγράφηκε, κατά την χρονική στιγμή των ηχογραφήσεων, γεγονός που συνδέει τη βιοποικιλότητα με την εποχικότητα. Πιο συγκεκριμένα, πραγματοποιήθηκαν τέσσερις φωτογραφικές λήψεις σε κάθε σημείο, καλύπτοντας όλες τις κατευθύνσεις με κυκλική προσέγγιση, εξασφαλίζοντας μια ολοκληρωμένη οπτικοακουστική αποτύπωση της περιοχής.



Εικόνα 4. Φωτογραφική απεικόνιση του φυσικού τοπίου και ορισμένων χαρακτηριστικών ειδών

2.4. Αφηγήματα

Κάθε σημείο, εκτός από την ηχητική καταγραφή και το φωτογραφικό υλικό, συνοδεύτηκε ως υλικό και με μια περιγραφή και ένα αφήγημα. Με την ερμηνεία περιβάλλοντος διαχέεται ευρύτερα η επιστημονική γνώση για τα περιβαλλοντικά δεδομένα μιας περιοχής, αλλά επιτυγχάνεται και η ανάδειξη της με μία πιο άμεση προς το ευρύ κοινό προσέγγιση. Η σημασία των αφηγημάτων είναι πολυδιάστατη, καθώς αποτελούν έναν από τους κύριους τρόπους επικοινωνίας για την κατανόηση του φυσικού περιβάλλοντος. Από την ομάδα των ερευνητών δημιουργήθηκαν 10 αφηγήματα, τα οποία συνέβαλαν στην περιγραφή του κάθε σημείου με πληροφορίες για τα οικοσυστήματα, τα είδη που απαντώνται, αλλά και το ηχοτοπίο που τα χαρακτηρίζει.

Στα σημεία που επιλέχθηκαν καταγράφηκαν ήχοι κατά την περίοδο της άνοιξης και ειδικότερα τον Μάιο. Η περιοχή του Γέρακα αλλά και του Καλαμακίου αποτελούν πέρασμα μεταναστευτικών πουλιών, γεγονός που ενδυναμώνει το εγχείρημα καταγραφής της βιοποικιλότητας στην ΠΠ και προσδίδει μία εν δυνάμει δυνατότητα σχεδιασμού της καταγραφής της ηχοποικιλότητας και στη συνέχεια παρακολούθησης πληθυσμών ειδών.

Παρατίθεται ενδεικτικά ένα αφήγημα, πρόκειται για το σημείο 4 της περιοχής του Καλαμακίου:

«Επιστρέφοντας στο αρχικό δρομάκι η περιέργεια εντεινόταν όλο και περισσότερο, καθώς κάθε βήμα, κάθε εικόνα και κάθε ήχος έκρυβε μια ξεχωριστή μαγεία που καλείσαι να ανακαλύψεις. Πλησιάζοντας όλο και πιο κοντά στη θάλασσα το τοπίο εναλλάσσεται απότομα αντικατοπτρίζοντας μια νέα πραγματικότητα. Τα πεύκα αρχίζουν να αραιώνουν και το δασικό οικοσύστημα παραδίδει την σκυτάλη στο αμμοθινικό. Ακόμα και αν οι ροδιές των αυτοκινήτων είχαν χαραχτεί βαθιά στην άμμο, μαρτυρώντας την ανθρώπινη παρουσία, τα βλέμματα κλέβουν τα ίχνη εντόμων και ερπετών. Ενώ, τα κρινάκια της θάλασσας με τους φιλοξενούμενους τους, τα σαλιγκαράκια, κερδίζουν όχι μόνο την προσοχή, αλλά και βραβείο φωτογραφίας. Πρόκειται για έναν κόσμο εντελώς διαφορετικό, που η αύρα του αλμυρού αέρα της θάλασσας σε αγκαλιάζει μαζί με την μυρωδιά του άγριου θυμαριού».

3. Συμπεράσματα - Συζήτηση

Η ευρύτερη περιοχή του κόλπου του Λαγανά στη Ζάκυνθο αποτελεί ΠΠ και βάσει του θεσμικού υφιστάμενου θεσμικού πλαισίου σκοπός της λειτουργίας της είναι η προστασία ειδών και οικοσυστημάτων τόσο στη χερσαία όσο και στη θαλάσσια περιοχή της. Η Ζάκυνθος αποτελεί διεθνώς γνωστό τουριστικό προορισμό και κάθε χρόνο φιλοξενεί περισσότερους από 1.500.000 τουρίστες. Η πρόκληση της συνύπαρξης ανθρώπου και φύσης είναι διαρκής και η βιώσιμη ανάπτυξη αποτελεί τη μόνη λύση ώστε να επιτευχθεί η προστασία και διατήρηση της φυσικής και πολιτιστικής κληρονομιάς στην περιοχή.

Το Καλαμάκι, φάνηκε να έχει ιδιαίτερη ηχοποικιλότητα. Η καταγραφή έδειξε ότι υπάρχουν ποικίλοι ήχοι, τόσο υποβάθρου και προσκηνίου όσο και ανθρώπινοι, βιολογικοί, γεωφυσικοί και μηχανικοί. Το Καλαμάκι αποτελεί τουριστικό προορισμό με αρκετές υποδομές κτιρίων και επιχειρήσεων στις όμορες των ηχοληψιών περιοχές. Επίσης, στην περιοχή υπάρχει οδικό δίκτυο που επηρέασε ηχητικά κάποιες από τις ηχογραφήσεις.

Παράλληλα, ο ηχοπερίπατος στο Γέρακα αποτυπώνει ηχητικά την πολυπλοκότητα των οικοσυστημάτων που συνυπάρχουν στις ΠΠ. Η ανθρώπινη παρουσία αισθητή αλλά διαφοροποιημένη σε ό,τι αφορά τη διαμόρφωση των ηχοτοπίων ως σύνολο, σε σχέση με το Καλαμάκι. Στο Γέρακα, τα ηχοτοπία είναι ιδιαίτερα διαφοροποιημένα μεταξύ τους λόγω της ιδιαίτερης γεωλογικής ταυτότητας της περιοχής.

Γενικότερα, οι ήχοι των βιότοπων έρχονται σε αντιπαράθεση με τους ήχους που παράγονται από την ανθρώπινη δραστηριότητα και εν δυνάμει επηρεάζουν μέσω της όχλησης που προκαλούν τη βιοποικιλότητα και ορισμένα είδη, όπως τη θαλάσσια χελώνα *Caretta caretta*. Η καταγραφή των ηχοτοπίων σε ΠΠ μπορεί να αποτελέσει εργαλείο παρακολούθησης ειδών και οικοσυστημάτων και παράλληλα μέσω δράσεων ευαισθητοποίησης, ενημέρωσης και επικοινωνίας να συμβάλλει στη διατήρηση της ισορροπίας μεταξύ της ανθρώπου και της φύσης.

Επιπροσθέτως, η προστασία και διαχείριση των ΠΠ αποτελεί προτεραιότητα, σε εθνικό και σε διεθνές επίπεδο, και η υιοθέτηση καινοτόμων πρακτικών και μεθόδων για την αποτελεσματικότερη λειτουργία των Μονάδων Διαχείρισης- ΟΦΥΠΕΚΑ δύναται να ενδυναμώσει τα διαχειριστικά εργαλεία. Η καταγραφή των ηχοτοπίων στις ΠΠ, σε συγκεκριμένες θέσεις και με συστηματικές χρονικές μετρήσεις εκτιμάται ότι θα προσφέρει πληροφορίες για τη βιοποικιλότητα και τα είδη, για τις οχλήσεις και τις ανθρωπογενείς παρεμβάσεις, για την ισορροπία των οικοσυστημάτων καθώς και για ενδεχόμενες περιβαλλοντικές αλλαγές και παραμέτρους που μπορεί να επηρεάσουν.

Παράλληλα, η δημιουργία υλικού ενημέρωσης, ευαισθητοποίησης και εκπαίδευσης με βάση την ηχητική ταυτότητα των ΠΠ προσδίδει μία νέα δυναμική στην προβολή της περιβαλλοντικής ταυτότητας οικολογικά σημαντικών περιοχών.

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Soundwalks at Protected Areas, The case study of the National Marine Park of Zakynthos

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Abstract

Protected Areas (PA) are national parks and wildlife refuges where legislative framework is setting rules for protection and management. The coexistence of humans and nature is a critical goal for sustainable development. PA are field, for scientific study and instruction on the ecological processes and conservation. Acoustic Ecology (AE) is an interaction of sounds in the environment and develops the acoustic perception, so human can cultivate an understanding the acoustic environment and gain an integrated experience.

Students run this research under the frame of the lesson AE of the Department of Environment, Ionian University which aims to create communicative material for the PA its ecosystems and biodiversity. A map and two paths have been created, while descriptions and narratives were compiled. The recordings of the soundscapes were executed utilizing high-fidelity audio equipment, adhering to the principles and methodologies of AE. The research emphasizes towards the examination of spatial variations in sound within natural ecosystems. An inventory of biodiversity, landforms and ecosystems found at each point was conducted. Virtual touring is engaging way for people to remotely discover places. By adopting virtual tours, we can lessen the negative effects of traditional tourism while opening up global chances for cross-cultural contact.

Keywords

Soundwalks, Soundscapes, Protected Areas, Acoustic Ecology, National Marine Park of Zakynthos

Exploring the sonic tapestry of insular Greece: spatial capture and systematic analysis of the Naxos’ Island soundscape

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Abstract

This research investigates the influence of human activity on the acoustic environment of Naxos’ Island, Greece, through an extensive set of recordings captured at 84 locations across the island, using First order Ambisonics. The recorded data is complemented by sound pressure level measurements and in situ sound source identification through active listening. The analysis includes sound source classification, comparison of the captured locations by region and a preliminary loudness analysis. Findings highlight the fact that although human activity may have an impact on the soundscape of Naxos, nature sounds still dominate the soundscape of the island. Sound recordings of all locations, accompanied by complementary information, are presented through an interactive Max/MSP application that allows users to spatially experience the unique spatial features of each site and to compare the auditory content of the recorded soundscapes by simply selecting locations on a map.

Keywords

acoustic ecology, soundscape research, spatial recording, ambisonics recordings, sound-source classification

1. Introduction

The concept of soundscape, introduced by R. Murray Schafer in the early 1970s, marked a shift in acoustic ecology by highlighting the relationship between sound and environmental processes (Schafer, 1969). This field emphasizes the perception and interpretation of sonic environments, highlighting their critical importance to individuals and societies alike (Truax, 1978). The International Organization for Standardization (ISO) defines soundscapes as “the acoustic environment as experienced, perceived, or understood by a person or people, in context” (International Organization for Standardization, 2014). As a reflection of ecosystem processes and human activities, soundscapes provide insight into the coupled dynamics of nature and society across varied scales (Pijanowski et al., 2011a, 2011b). Globally, rapid environmental transformations driven by natural and economic forces reshape ecosystems, wildlife, and human activities, frequently altering established soundscapes. As soundscapes embody the intricate relationships between natural and human-made sounds, they offer a valuable framework for studying the acoustic impact of human activities within specific environments (Burivalova et al., 2018; Proulx et al., 2019; Ulloa et al., 2021).

Naxos is the largest island in Cyclades with an area of 430 km², a 148 km coastline and a population of roughly 22,500 people, a number that increases notably during the tourist season. Its diverse geomorphology, climate and cultural activities contribute to a unique and complex soundscape. The expansion of tourism prompts the use of Acoustic Ecology as a method to assess how such development influences the auditory environment of the island. Acoustic Ecology provides tools for analyzing ecological and human-driven processes that shape soundscapes, facilitating a deeper understanding of the acoustic effects of tourism (Dedousis et al., 2021; Matsinos et al., 2017; Matsinos & Tsaligopoulos, 2018; Vogiatzis & Rémy, 2018). Moreover, examining how human activities alter soundscapes can help reconstruct traditional soundscapes, underscoring the importance of preserving acoustic heritage as part of environmental and cultural sustainability efforts (Bartalucci & Luzzi, 2020; Jordan, 2016; Sun, 2023; Yelmi, 2016). Through rigorous soundscape analysis, researchers can document

the acoustic imprints left by tourism, essential for developing strategies to mitigate negative impacts and safeguard the distinct sonic identities of locations like Naxos. Soundscape perception also plays a substantial role in shaping tourists' experiences (Jiang, 2022; Lu et al., 2022; Qiu et al., 2018).

Historically, audio technologies have focused on capturing and reproducing the temporal aspects of soundscapes. However, recent advancements emphasize the importance of spatial attributes for realistic and immersive playback experiences (Hong et al., 2017; Sun, 2023). Innovations in spatial audio technology, such as binaural (Sochaczewska et al., 2017) and Ambisonics recordings (Dedousis et al., 2021; Małeck et al., 2016), present promising opportunities in Acoustic Ecology, enabling a more comprehensive capture of soundscapes and supporting the interdisciplinary aims of the field.

This study explores the soundscape of Naxos by identifying and categorizing sound events from field recordings, investigating correlations between auditory content and human activities, especially tourism. Furthermore, it introduces an interactive tool that utilizes spatial audio technology to provide users with an immersive auditory experience of the island's soundscapes.

2. Methodology

2.1. Data Collection

To comprehensively capture the diversity of soundscapes on the Naxos Island, 84 distinct recording sites were selected. These sites represented a range of environments, including villages of varying sizes, beaches, tourist hotspots, archaeological areas and zones of infrastructure development. These sites were grouped into six geographical clusters based on location, accessibility, and levels of tourist activity. This classification was developed through consultation with local residents, in order to better understand how tourism influences soundscape authenticity in relation to estimated visitor levels.

These six geographical regions were: Naxos Chora (west), Central Naxos, Southwest, Southeast, Northwest, and Northeast. Naxos Chora (the main town) is the island's most densely populated area, similar to other Choras in the Cyclades. During the summer, tourists predominantly stay in Chora and the southwestern region, attracted by accessible beaches and the ample tourist accommodations. Conversely, Central and Northeast Naxos host a mix of small villages frequented by tourists, while Southeast and Northwest Naxos experience significantly less tourist activity.

The clusters are categorized by touristic intensity, as shown in Figure 1. High-tourism areas include Naxos Chora (locations 1-6, marked in red) and Southwest Naxos (locations 72-84, marked in orange). Medium-tourism areas comprise Central Naxos (locations 7-20, marked in yellow) and Northeast Naxos (locations 55-71, marked in purple). Low-tourism areas include Southeast Naxos (locations 34-54, marked in green) and Northwest Naxos (locations 21-33, marked in blue).

Recording sessions were carried out from July 7 to August 21, 2023, within the timeframe of 12:00 PM to 6:30 PM, with individual recordings lasting from 5 to 20 minutes. One of the authors was present during each session to observe and document sound sources in real-time—a standard practice in Soundscape analysis. To confirm the accuracy of these observations, recordings were later reviewed in binaural format, allowing for precise identification of each sound source. Following verification, sounds were categorized systematically and arranged into a hierarchical structure comprising four primary groups: Human, Nature, Mechanical and Music, based on the taxonomy proposed by Salamon et al (2014).

2.2. Recordings

Soundscape recordings on Naxos were conducted using the First Order Ambisonics (FOA) technique, chosen for its flexibility in delivering immersive audio playback compatible with multiple formats, including binaural, 5.1 surround and custom multi-speaker setups. A Zoom H3-VR field recorder, alongside its integrated Zoom Ambisonics Player software, was employed to capture these recordings. To ensure optimal audio fidelity, recordings were made at the highest available settings: a sample frequency of 96 kHz and a bit depth of 24-bit. Given the frequent windy conditions on the island, a Zoom WSU-1 hairy windscreen was used to effectively reduce wind interference.

Sound Pressure Level (SPL) measurements were taken with the INGCO HETSL01 digital sound level meter, which documented maximum and minimum sound levels (dB A-weighted) for each recording session. Due to the high temperatures experienced on the island during the time of the measurements, a custom sun-proof cover resembling a large hat was designed and positioned slightly above the recording equipment to shield the gear from heat without compromising sound quality.



Figure 1. Map of the Naxos Island showcasing recording locations, indexed and color-coded by group

Gain settings on the recorder were adjusted to suit the ambient sound levels at each site. Quality control was maintained through real-time monitoring via in-ear headphones, allowing for prompt responses to unexpected disturbances by means of pausing and resuming the recording. Live monitoring of the recorded content enabled precise documentation of the individual sound sources within each soundscape. Additionally, each session was documented with a photograph of the surroundings at the recording location and exact GPS coordinates recorded via a geo-tracking device.

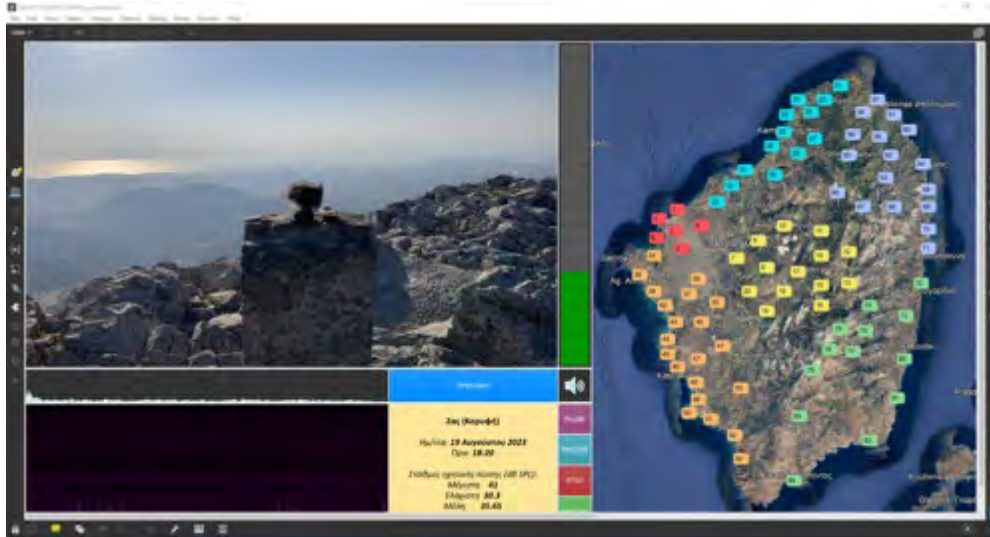
2.3. Interactive Application

An interactive application prototype was developed in Max/MSP, enabling users to navigate a map of Naxos and select from the 84 recorded locations to experience the island's soundscapes. To convey the spatial depth of each sound environment, the Ambisonics B-format recordings (AmbiX) were converted to binaural format using the dearVR AMBI MICRO VST plugin. Currently, the application supports static listening, but it is designed to be expandable to accommodate dynamic head tracking, allowing the sound rendering to adapt to changes in the listener's orientation for a more immersive experience.

The application can also be adapted to include personalized Head-Related Transfer Functions (HRTFs) in SOFA file format. This enhancement would further refine the auditory realism by tailoring the sound experience to each user's spatial hearing profile. Figure 2 shows a snapshot of the application's interface. When a location is selected, users see an image of the corresponding landscape (top left), a real-time sound level meter showing fluctuations in sound pressure (highlighted in green in the center) and a spectrogram display (bottom left). Additional information, including the site's name, date and time of the recording, and the maximum, minimum

and average sound levels (dBA), appears in a yellow information box at the bottom center of the screen, while a map of Naxos is displayed on the right.

Users can interact with the soundscape through playback controls such as play, pause, resume, stop and restart, and can adjust audio levels via a gain slider. Seamless navigation between different recording sites is facilitated by simply selecting new points on the map, allowing for an engaging exploration of Naxos's diverse auditory environments.



numerous tourist accommodations, restaurants, and beach bars. Thus, 61.32% of the auditory environment is tied to human activity, primarily associated with tourism. Specific sounds, like Beachware and Restaurant ambience, emphasize the impact of tourist activities on the soundscape of the southwest part of the island.

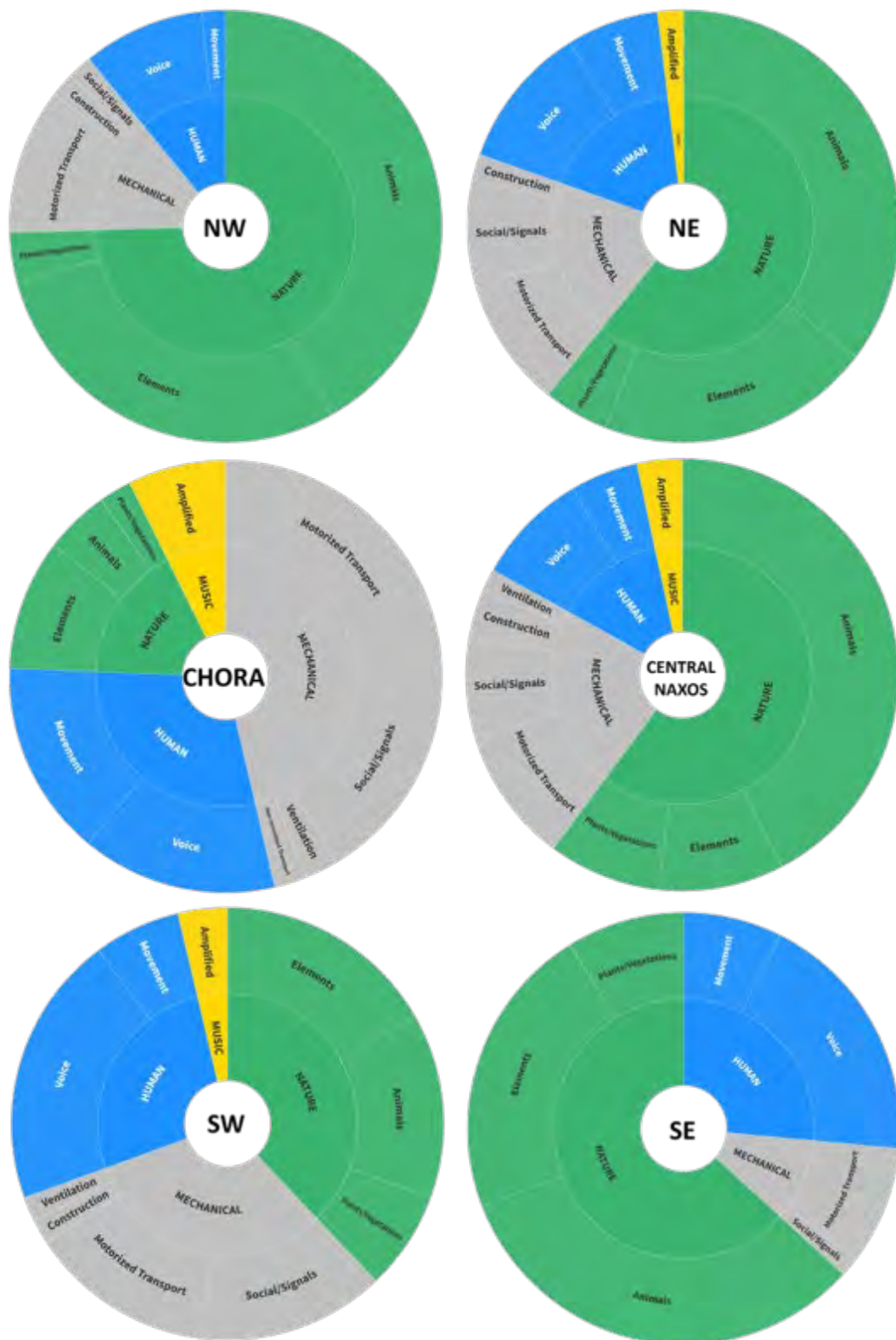


Figure 3. Comparative Analysis of sound sources per category and region in Naxos

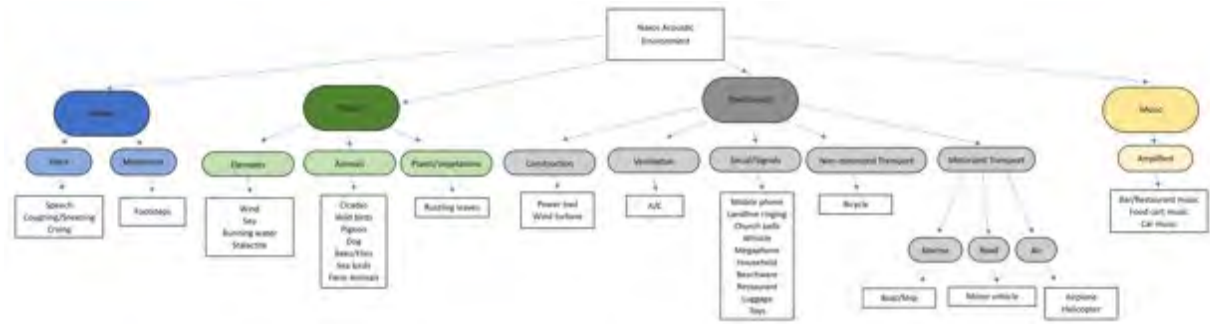


Figure 4. Naxos sound sources classification tree

In the Southeast, Nature sounds prevail, comprising 63.24% of the soundscape. Characteristic sound-sources include but are not limited to Cicadas, Bees/Flies and Farm Animals. Human sounds account for 26.47% of the sound-sources, which include Voices, Footsteps and Baby Cry, while Mechanical sounds, mainly Motor Vehicles, account for just 10.29% of the recorded data. The low presence of Mechanical sounds and the absence of Music suggest that this region retains a more pristine character, relatively unaffected by tourism.

The Northwest region, despite its larger population, shows no Music sources and a minimal presence of Mechanical sounds (14.55%), mainly from Motor Vehicles. Human sounds, mostly Voices, make up 10.91% of the sonic content, while Nature sounds are dominant at 74.55%, featuring Cicadas, Bees/Flies, Dogs, Farm Animals, Running Water, and Sea Birds. Both the Southeast and Northwest regions reflect the least tourist influence, as evidenced by the predominance of Nature sounds in these areas.

Central and Northeast Naxos's soundscape, in an area with moderate tourist activity, is more akin to those of the less touristic areas than to those of the highly touristic ones. In Central Naxos, the soundscape consists of 62.83% Nature sounds, 14.16% Human sounds, 21.24% Mechanical sounds, and 1.77% Music. Similarly, Northeast Naxos shows 60.78% Nature sounds, 17.65% Human sounds, 19.61% Mechanical sounds, and 1.96% Music. Across Naxos, with the exception of Chora where Nature sounds account for less than one-fifth of the soundscape, Nature sounds range from 38.68% to 74.55%, with a median of 60.78%, suggesting that while tourism affects the island's soundscape, Nature sounds remain a key auditory content, preserving the island's natural acoustic character.

Figure 4 presents a taxonomy of sound sources across Naxos, organized by category according to the classification method outlined in [24]. High-level semantic categories, such as Mechanical Sounds, are represented by rounded rectangles, encapsulating broad sound classifications. The final nodes of the taxonomy, displayed as rectangles with sharp edges, correspond to specific, concrete sound sources (e.g., Footsteps), providing a detailed breakdown of the diverse auditory elements identified on the island.

3.2. Preliminary Loudness Analysis

Figure 5 shows the average loudness levels (dBA) at each of the measured location around Naxos. As can be seen, the loudest areas of the island are concentrated in the Southwest, particularly around Mikri Vigla and in Filoti in Central Naxos. Both locations, along with parts of Chora, have high tourist activity and noise levels. Filoti's higher population density also plays a notable role in its overall loudness. Similarly, in the Northwest, a region with comparatively low tourist activity, certain areas also display elevated sound levels. Along the main roads connecting villages—such as Agias-Abram Road (71.7 dBA) and Apollona-Agias road (71.6 dBA)—noise levels are notably higher, as is the area around the Eggares Reservoir, a popular tourist spot.

The noise heat map, thus, illustrates the distribution of sound sources across Naxos, helping to identify specific regions with heightened noise levels. In Chora, several areas appear in orange, indicating moderately high sound levels, while the majority of the Southwest shows a lower noise profile, despite sharing similar sound sources with Chora. This difference likely stems from the particular recording locations selected; additional data collection could provide a clearer understanding of the factors behind these variations.

However, sound level data alone do not capture the full spectrum of a location's noise profile, as it lacks specificity regarding sound source categories. For example, the presence of both motor vehicles and cicadas can raise sound levels significantly, but each creates distinctly different auditory environments. Thus, a qualitative

analysis that considers the nature of sound sources is essential to gain a comprehensive understanding of the auditory dynamics across Naxos.

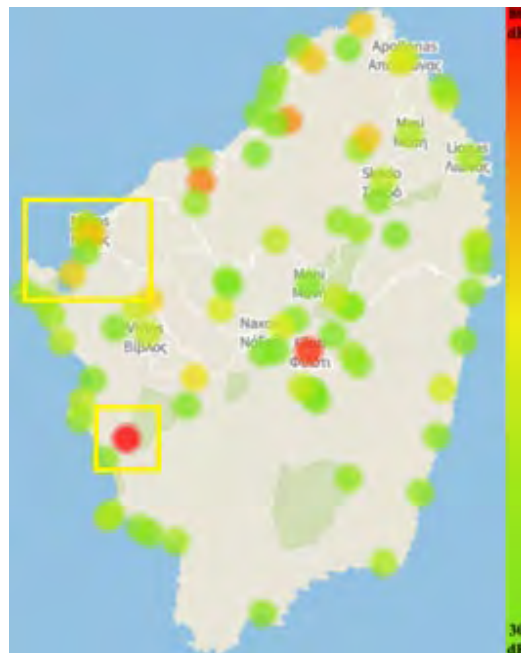


Figure 5. Loudness Heatmap of Naxos illustrating the varying loudness levels across the island. Color gradations from green to red indicate the range of sound intensities from 30 dBA to 80 dBA

4. Conclusions and Future Work

This study presented a preliminary analysis of sound recordings from 84 locations across Naxos, examining environmental, wildlife and human-related sounds, focusing on the impact of tourism on the soundscape of the island. Results show that in Chora, 82.93% of the sounds originate from human activities (Human, Mechanical, and Music categories), while only 17.07% are Nature oriented. As nearly half of the island’s residents live in Chora, these sounds largely reflect general human activity rather than being solely tourist-related. Future studies will include measurements during low-tourism periods, in to better understand the effect of tourism on the soundscape of the island.

In the Southwest of Naxos, a key tourist area with fewer residents, Nature sounds comprise 38.68% of the soundscape, and noise levels are moderate, suggesting that natural sounds remain prominent even amid human activities. Human-related sounds (including Music, Human, and Mechanical) make up 61.32% of the soundscape, including sources such as Beachware, Motor Vehicles and Restaurant ambience. These findings suggest that while tourism influences the island’s soundscape, natural sounds still feature strongly. Additional recordings outside of the peak tourist season will help detect shifts in composition of sound and volume.

Hence, future work will expand data collection across seasons and locations, incorporating environmental factors such as time of day, wind speed, and temperature to better understand their influence on the soundscape. This will create a comprehensive database for long-term monitoring of the Naxos’ soundscape, examining the interactions between dynamic environmental factors and the acoustic impact of tourism.

The interactive tool developed for this study will also support subjective analysis of the auditory content. Building on this tool, we envision an immersive virtual “sound-travel” experience of Naxos that leverages spatial sound technology. Consistent with prior research (Dedousis & Andreopoulou, 2023), we aim to refine this tool by evaluating its ecological validity in controlled settings. Planned upgrades include dynamic binaural rendering responsive to head movements and integration of personalized HRTFs for a more customized auditory experience. Visual enhancements, such as panoramic photos and immersive 360-degree videos, will be introduced to offer a more realistic and engaging multisensory experience. This experimental setup will provide valuable insights into the users’ perceptions and expectations for experiencing the spatial characteristics of a soundscape remotely.

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Resonant Echoes: Acoustic Heritage and Cultural Memory in the Mani Peninsula

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Abstract

This study explores the acoustic heritage of the Mani Peninsula, a region renowned for its rugged landscapes and unique cultural identity shaped by isolation and tradition. Drawing from ethnographic fieldwork, physiological data and participant narratives, we examine how natural sounds—particularly water and wind—act as cultural anchors, influencing residents' perceptions of memory, place and identity. Through participant-led sound recordings and workshops, the research captures the immediate, sensory connections that Mani residents hold with their environment, focusing on the physiological responses and emotions these sounds elicit. The findings suggest that the local soundscape is more than an auditory background; it is a living archive of cultural memory, with sounds like sheep bells, waves, and church bells invoking nostalgia, connection and environmental awareness across generations. These sensory experiences were underscored by increased alpha and theta brainwave activity, reflecting states of relaxation and introspection, while heightened beta waves during moments of focus suggested that familiar sounds play a role in memory encoding.

Our interdisciplinary approach bridges ethnographic and physiological data, offering new insights into how sound can be documented and preserved as a form of cultural heritage. By emphasising community participation and sensory engagement, this study contributes to sensory anthropology and acoustic heritage research, providing a model that can be applied to other Mediterranean and rural regions facing challenges from urbanisation and economic shifts. The study highlights the importance of listening as an ethnographic tool, suggesting that sound, as a sensory experience, is integral to understanding and preserving the intangible bonds between people, place, and cultural memory. Future research could expand on this work by exploring multisensory ethnographic methods and the use of physiological data to deepen our understanding of soundscapes as vehicles for community identity and resilience.

Keywords

Acoustic heritage, cultural memory, Mani Peninsula, ethnographic fieldwork, physiological data, natural soundscapes, place and identity, memory encoding, sensory anthropology, community participation

1. The Mani Peninsula

The Mani Peninsula, a remote and rugged region in the Greek Peloponnese, is known not only for its harsh, beautiful landscapes but also for a unique cultural legacy shaped by centuries of semi-isolation. Studies, such as *The Laconia Survey* by Cavanagh and Mee (1996, p.7), reveal how the Mani's environmental and human geography, deeply intertwined with agricultural activities and ancient settlement patterns, contribute to the region's distinctive soundscape. The sounds of olive pressing, sheep herding and seasonal harvesting once filled the landscape, accompanied by the natural acoustics of flowing rivers and the whistle of winds through the olive groves. These historical and environmental rhythms persist as acoustic signatures of the region, with sounds from nature and human activities blending to create an enduring sonic layer that shapes local identity and memory.

Authors like Patrick Leigh Fermor, in *Mani: Travels in the Southern Peloponnese* (1958, p. 134), capture the powerful influence of Mani's natural elements, emphasising the auditory experience of wind through valleys, waves crashing on rocky coastlines and the echo of church bells in isolated villages. These sounds function not only as sensory markers of place but also as carriers of cultural memory, symbolising the resilience and spiritual

life of the Maniots, who have withstood environmental hardships and economic shifts over time. Building on Fermor’s observations, this study seeks to document and interpret the soundscape as an evolving cultural archive—an *acoustic heritage* that speaks to the deep connection between residents and their land.

1.1. Research Purpose and Objectives

This research aims to capture the acoustic heritage of the Mani Peninsula, focusing on how natural sounds—particularly water and wind—intersect with residents’ perceptions of place, memory and identity. Utilising accessible technology and physiological sensors, this interdisciplinary study seeks to document and analyse the soundscapes of the Mani through the narratives of its residents, combining ethnographic fieldwork with physiological data to explore the immediate, embodied experiences elicited by these sounds. Themes of generational disconnection, driven by urban migration and a sense of environmental degradation underlie this investigation, reflecting broader concerns for the survival of rural cultural landscapes across the Mediterranean.

1.1.1. Research Questions

This study is guided by several research questions that address the layers of meaning embedded in Mani’s soundscape:

- How do sounds from natural sources, such as water and wind, shape cultural memory and perceptions of place in Mani?
- What role do residents assign to specific environmental sounds and how do these auditory elements foster connection or continuity with the past?
- How do physiological responses (such as brain rhythms) to natural sounds relate to residents’ feelings of place attachment, tranquillity or nostalgia?

Through these questions, this research aims to uncover the relationships between sound, memory and identity, with an emphasis on how residents perceive and respond to Mani’s soundscape in both emotional and physiological terms.

1.1.2. Significance and Contributions

The integration of ethnographic and physiological data in this study represents an innovative approach to documenting acoustic heritage. Building on Cox, Wright, and Irving’s *Beyond Text? Critical Practices and Sensory Anthropology* (2009), this project seeks to move beyond traditional textual documentation by employing sound recordings and physiological data to capture sensory and embodied ways of knowing. By emphasising participant-led recordings and physiological responses, the study provides an immediate, intimate insight into how sound reflects and influences identity, memory and environmental perceptions.

In a broader sense, this study contributes to Mediterranean and acoustic heritage research by proposing methods for understanding and preserving the intangible, sensory aspects of rural landscapes under threat from urbanisation and economic change. The findings offer a framework for similar investigations into the impact of sound on cultural memory, ultimately enriching our understanding of the relationship between place, sound, and community in an increasingly urbanised world.

1.2. Sound, Memory and Place

The interplay between sound and memory has garnered attention in sensory anthropology, where scholars explore how sound functions as a powerful mnemonic device that anchors individuals within their environments. In *Beyond Text? Critical Practices and Sensory Anthropology*, Cox, Wright and Irving (2009) advocate for a shift from traditional, text-based ethnography toward sensory methodologies that capture the immediacy of human experience. Sound, as Amelides (2016) and Devito (2021) emphasise, enriches ethnographic narratives by invoking *acoustic heritage*—a term that captures the enduring influence of environmental sounds on cultural memory and identity. These studies underscore that sound not only reflects but actively shapes social spaces, creating what LaBelle (2010) calls *acoustic territories*, where the relational dynamics of human interactions and environmental sounds converge to produce a distinct cultural landscape.

The field of sonic ethnography builds on these insights, with practitioners using auditory methods to document cultural memory in ways that text alone cannot capture. Amelides' concept of *acousmatic storytelling* illustrates how layering interviews, ambient recordings and music engages listeners as co-creators, experiencing the narrative on both emotional and sensory levels. This immersive approach, as Devito discusses, fosters *sonic empathy*, connecting audiences with shared histories and experiences embedded in specific places. Together, these works highlight the potential for sound to serve as both a repository and transmitter of cultural knowledge, as sonic landscapes evoke embodied memories tied to place.

1.2.1. Embodied Ethnographic Methods

The physical engagement with landscapes through movement, particularly walking, is increasingly recognised as an essential aspect of ethnographic research. Aduonum's work (2021) on *walking as fieldwork* underscores how movement allows researchers to interact directly with cultural practices, local rhythms and environmental scales. In our study, walking was not only a method for recording sounds but also a means through which participants and researchers could intimately connect with the Mani landscape, experiencing the area's layered sounds within their natural settings. Walking, as Lawhon and Pierce (2015) further emphasise, facilitates an immersive experience where researchers can encounter serendipitous cultural expressions and connect deeply with the spatiality of everyday life. Impey's (2018) exploration of *song walking* extends this concept, showing how walking attunes researchers to the memory and meaning embedded in landscapes, enabling a sensory engagement with place that aligns with the rhythms and silences of local life. Impey also identifies silence as a strategic, often resistive element within cultural narratives, underscoring its communicative significance and highlighting the complex dynamics researchers must navigate when interpreting unspoken cultural cues.

The concept of *Live Methods*, as articulated by Black and Puwar (2012), situates sensory engagement as a dynamic, real-time form of ethnographic research that opens new possibilities for exploring embodied experiences. Their manifesto encourages a collaborative and fluid approach to ethnographic practice, advocating for the integration of multimedia, aesthetics and real-time observation. LaBelle's (2010) notion of *acoustic territories* further contributes to this approach, suggesting that sound and its perception help to demarcate social and cultural spaces. These acoustic territories are not only geographic but also socio-cultural, encapsulating the lived, auditory experiences that define community spaces and shape interactions.

1.2.2. Technological and Physiological Approaches in Ethnography

In recent years, technological advancements have facilitated new approaches in ethnographic research, allowing for the integration of physiological data to better understand sensory responses to environmental stimuli. Rennie's (2014) Socio-Sonic methodology advocates for an ethnographic approach that views sound as both a cultural context and an abstract phenomenon, positioning sound recordings as a form of *note-taking* that transcends textual limitations. Drever (2012) similarly emphasises the need for *aural diversity* within sonic arts, recognizing that the human auditory experience is varied and deeply personal, which aligns with the technological advancements that now permit nuanced exploration of listener diversity.

The use of EEG sensors and other biometric tools has opened up new possibilities for examining physiological responses to sound. Studies by Duvinage et al. (2012) and Wu, Wang and Wang (2013) highlight the role of EEG devices in capturing real-time cognitive responses, particularly in response to music and ambient soundscapes. These technological tools facilitate a more empirical approach to understanding the embodied impact of sound, offering a means to quantify physiological markers, such as relaxation or emotional arousal, that are otherwise difficult to articulate. This approach supports a more holistic understanding of cultural engagement, allowing ethnographers to document not only the perceptual but also the physiological dimensions of sound as they manifest in individual experience.

1.3. Ethnographic Fieldwork and Interviews

The ethnographic fieldwork in Mani took place through a series of encounters woven into the daily life of the community, with the aim of exploring not only the soundscape itself but the intricate ways in which it intersects with local identity and memory. The fieldwork began with informal conversations in cafes, local gathering spots and often at the participants' homes, where people spoke freely, offering stories and impressions of Mani's

soundscape in the context of their everyday lives. Participants included a cross-section of residents—elderly villagers with deep roots in the region, middle-aged returnees who had spent time away from Mani and younger individuals who visited seasonally or had moved back in recent years. These conversations helped identify the sounds that resonated most deeply with participants, including water running through age-old channels, bells from hillside chapels and the ambient sounds of animals and agriculture.

Throughout these conversations, certain themes emerged that reflected cultural values associated with sound. Notes and audio recordings were reviewed to identify recurring ideas, with a focus on how participants linked specific sounds to memory, emotion, and place. Rather than applying a rigid framework, the interview material was approached inductively, allowing patterns and meanings to emerge organically through repeated listening and thematic clustering. Participants often described the sound of water as a “living pulse” of the village, linking it to ideas of abundance and continuity that felt especially valuable in the rocky and arid landscape of Mani. Many of the elderly residents spoke of their childhoods, when the natural sounds of wind and water were primary markers of time and season. One participant, a man in his 70s, recalled how the gurgling of springs and the rustle of olive trees guided his family’s work cycles, reflecting a time when life was more closely attuned to the rhythms of the natural environment.

During the more formal interviews, which followed these initial encounters, participants opened up about the emotive and often symbolic associations they held with specific sounds. The tolling of the church bells, for instance, was not merely a call to prayer; many participants described it as a reminder of shared faith and resilience, particularly significant in Mani’s history of resistance and autonomy. A local woman in her late 60s, whose family had lived in the area for generations, spoke of the bells as a sound that “carries our spirit across the mountains”, linking the physical geography to a broader, almost mythical, sense of collective identity. In observing the participants during these interviews, it was clear that their reflections on sound were tied to a deeper understanding of place, with sensory memories that evoked both nostalgia and pride in their heritage.

1.3.1. Participatory Sound Recordings

The fieldwork continued with participatory workshops, designed to immerse participants in the act of sound recording and, in doing so, invite them to explore Mani’s auditory world with fresh attention. These workshops were held in the village centre and included residents of varying ages, from elders recounting ancestral practices to younger locals eager to learn more about their community’s traditions. The first part of each workshop involved a brief introduction to sound recording techniques, after which participants were encouraged to venture into familiar landscapes and capture sounds that held personal meaning.

During the recording sessions, many participants expressed surprise at how much could be discovered through attentive listening. Walking through olive groves, down narrow paths lined with dry stone walls, or along the shorelines, the residents often paused and cocked their heads to catch subtleties in the environment they hadn’t noticed before. One young man, originally skeptical about the importance of sound, commented on the “hidden language of the land” after he captured the layered calls of hawks mingling with the distant sounds of goat bells. His experience, along with others, reflected an emerging sense of pride in the aural qualities of Mani, as participants realised the extent to which these sounds formed a unique cultural lexicon.

1.3.2. Participant Groups and Memory-Based Response to Sound

To deepen the analysis of sound’s impact on memory and emotional recall, participants were divided into four groups based on their background and connection to Mani:

- Group 1: Younger participants who had spent time in the village, though they did not live there.
- Group 2: Older participants with similar village experience, recalling their time spent in Mani.
- Group 3: Elderly participants currently living in the village, maintaining active lives within this soundscape.
- Group 4: Visitors with multiple visits to Mani, holding an external yet repeated familiarity with its sounds.

This arrangement enabled us to assess how sensory exposure to Mani’s sounds influenced memory, cognitive states, and physiological responses, providing insights into whether these responses were linked to direct personal experience or general familiarity with the village environment.

1.3.3. Physiological Data Collection Using EEG, GSR, and HR

Physiological measurements were a key component of this study, gathered through the NeuroSky Mindwave headset, a Grove GSR sensor, and a heartbeat monitor. These tools provided real-time data reflecting cognitive states—Attention and Meditation—based on NeuroSky’s proprietary algorithms, which translate raw EEG signals into actionable values. The NeuroSky system’s metrics are grounded in specific brainwave frequencies; “Attention” is related to heightened activity in the beta, gamma, and alpha ranges, indicative of cognitive focus and mental processing, while “Meditation” corresponds to theta and alpha waves, which are typically associated with relaxation and mental calmness (Lee & Tan, 2016, pp. 51–52). These eSense metrics offer a simplified, non-clinical representation of brain activity, making them ideal for exploratory studies in accessible, educational environments.

Despite being a consumer-grade device, the NeuroSky Mindwave effectively captures EEG data suited for applications involving basic brain-computer interface tasks, such as attention-focused interactions (Duvinage et al., 2012, p. 17). Notably, beta wave activity, particularly in the 25–30 Hz range, became prominent during moments of high attention across different groups. Participants in Group 1 showed exhibited peak Attention levels averaging around 78.2, while Group 3 showed peaks at approximately 79.6, corresponding to deep cognitive focus during moments of engagement with the soundscape. These values, though not as precise as medical-grade EEG data, provided insightful approximations of mental states that, when combined with personal reflections, revealed layered responses to Mani’s auditory heritage.

1.3.4. Workshops and Sound-Based Interactive Exploration

The workshops created an immersive environment for participants to reconnect with Mani’s soundscape, blending auditory experience with physiological monitoring to offer a profound and multifaceted exploration of memory, heritage and embodiment. Each session began with an introduction to the principles of sound recording and the use of EEG, GSR and HR sensors, which enabled participants to observe and track their bodily responses to familiar sounds. Divided into small groups, participants listened to pre-recorded soundscapes featuring the natural and cultural sounds of Mani, such as the rhythmic bells of sheep, the resonant hum of the village square, the steady rush of the local spring and the ever-present lull of the sea’s waves against pebbled shores.

In the workshop space, participants took turns sharing and listening to each other’s recordings through headphones. As they observed the nuances in their sound captures, discussions emerged that transformed these recordings from mere sounds into meaningful narratives and symbols of their enduring ties to Mani’s landscape. A quiet reverence permeated these sessions as participants came to view the sounds as extensions of their personal histories. In one instance, an elderly woman spoke of the changing sound of the sea, recalling a decades-old storm that altered the coastline and, consequently, the waves’ tonal quality. Reflections like these revealed Mani’s soundscape to be not a static backdrop but an evolving entity, intricately woven into the collective memory and daily rhythms of the village.

Physiological monitoring added another dimension to these explorations, as participants used EEG and heart rate sensors to observe their reactions in real-time. This aspect of the workshop was met with fascination as they noted how particular sounds impacted their Attention and Meditation levels. Familiar or soothing sounds such as the creak of a wooden door or the calm rush of water from the spring elicited visible relaxation in both EEG and heart rate readings, showing increased Meditation levels. In contrast, sudden, louder sounds—like a goat’s bleat or the piercing call of a hawk—sparked sharper physiological responses. The sheep bells, in particular, prompted a deepening of Meditation levels among elderly residents, likely due to the comforting familiarity of the sound and its associations with pastoral life.

During post-session discussions, participants reflected on their experiences, often sharing memories or insights that tied their reactions to the landscape’s deeper layers of meaning. Many observed that certain sounds, such as the church bells or the distant ambience of nature, farms, animals and labourers, stirred feelings they described as a “pull” or “call” to something familiar and grounding. Younger participants, particularly those in Group 1, noted that sounds from the village square made them feel “alert”, “familiar”, “excited” etc., hinting at the potential for these spaces to form both echoic references and new memories in a rapidly evolving environment. These conversations, alongside the recorded physical responses, illustrate the deeply felt nature of Mani’s auditory heritage and highlighted how the village’s Acoustic Ecology resonates across different generations, merging personal memories with a collective sense of place.

1.3.5. Analysing Cognitive and Physiological Responses

The captured physiological data were interpreted alongside narrative reflections to create a composite picture of participant engagement with Mani’s auditory landscape. Alpha and theta brainwave activity were noted during instances of Meditation, particularly in response to more serene soundscapes such as the sea’s lapping or the wind among the olive trees, which evoked states of calmness and reflection. By correlating physiological data with participants’ recorded memories and emotions, we could trace how these soundscapes functioned as triggers for both physical relaxation and emotional arousal.

Heart rate data, similarly, revealed intriguing patterns tied to personal memory. For example, the historical square’s sounds often elicited a slight rise in heart rate among Group 2, indicating a form of arousal linked to memory recall, while Group 4’s external familiarity with the square produced more neutral physiological responses. Galvanic Skin Response (GSR) levels, captured using the Grove sensor, further allowed us to assess emotional arousal in real-time, providing added nuance to our understanding of how these soundscapes resonated on a sensory level.

Through this study, the combined approach of physiological monitoring and ethnographic observation underscored how deeply ingrained the soundscape is in the lives and identities of Mani residents. Whether through a rise in cognitive attention or an increase in emotional arousal, the responses provided insight into the profound relationship between sound, memory and place, revealing the manifold ways that sensory heritage continues to shape and enrich everyday life in Mani.

1.4. Emotional and Cognitive Impact of Natural Sounds

The analysis revealed that natural sounds, particularly water elements like the sea and local streams, elicited potent emotional and cognitive responses. Physiologically, participants showed heightened alpha and theta wave activity, both associated with states of relaxation and mindfulness, in response to these natural soundscapes. Younger participants (Group 1) and elderly residents (Group 3) showed notable peaks in attention and emotional arousal when exposed to familiar sounds, as indicated by increases in both heart rate and galvanic skin response (GSR). For instance, Group 1 participants recorded attention levels averaging 64.3, with their highest heart rate responses occurring during these sounds, peaking at 80 BPM. Meanwhile, the meditative and tranquil effects of water sounds seemed particularly impactful on Group 3’s elderly participants, reinforcing the link between sensory engagement with nature and calm, reflective mental states.

The auditory experience often triggered multisensory memory recall, where participants reported visualising scenes from the village, suggesting that the auditory cues were closely tied to stored memories of specific places and events. For example, the sound of the sea prompted images of peaceful days on the shore, while the church bells recalled festive gatherings. These responses are further validated by the prevalence of theta wave activity during meditation across groups, demonstrating a connection between these natural sounds and relaxed cognitive states, especially among participants who shared stronger emotional ties with the village. Beta wave activity, critical for memory encoding, further indicated that the soundscapes were not merely passive stimuli; instead, they functioned as cognitive cues that deepened memory retention and recall, solidifying these natural sounds as emotional anchors within participants’ minds.

1.4.1. Community Narratives and Acoustic Knowing

The narratives shared by participants underscored the soundscape of Mani as a significant component of cultural heritage. Across all groups, participants articulated memories and emotions that tied the landscape’s sounds to family, community and personal history. Younger participants often associated village sounds with childhood memories and family moments in communal spaces, while older residents described a more profound connection, recounting decades-old memories that these sounds evoked. For instance, one participant from Group 2 described how the rhythmic chisel on stone connected him to the village’s workshops, embodying the historical pride of hands shaping their world.

In terms of generational perspective, elderly participants, particularly from Group 3, experienced a powerful resonance with sounds like sheep bells and church bells. These sounds held a deep nostalgic value, symbolising pastoral life and community rituals. Participants from Group 4 (visitors) exhibited lower emotional peaks overall but noted how specific sounds, like the ringing of church bells or the sea, connected them to experiences within

Mani, bridging personal and cultural identities. This generational divide illustrates how urbanisation and migration might be altering perceptions of acoustic heritage, with older residents viewing these sounds as irreplaceable elements of their identity, while younger generations and visitors perceive them with a blend of familiarity and novelty, shaped by intermittent or transient visits.

1.4.2. Expanding Ethnography: Soundscapes as Cultural Memory and Sensory Heritage

The participant-led sound recording process enabled a novel, immersive form of ethnographic representation that goes beyond traditional textual limitations. Through their active involvement in capturing Mani’s soundscapes, participants were able to reflect on their cultural identity and contribute to preserving an acoustic archive unique to their community. This method highlighted the importance of sensory-driven narratives, allowing participants to directly contribute to the ethnographic portrayal of their surroundings, thus enriching the depth and authenticity of the data collected.

Merging EEG and ethnography provided additional layers of understanding, linking sensory data to memory and identity. For instance, physiological measures such as EEG readings allowed researchers to identify correlations between alpha and theta waves and moments of calm and reflection, particularly when participants engaged with sounds like water or bells. This approach underscores how integrating sensory and physiological data deepens our understanding of cultural identity, allowing us to quantify not only how sounds evoke memories but also how they impact participants’ mental and emotional states in real time. By combining narrative analysis with physiological responses, this study emphasises a multisensory, experiential perspective that enriches ethnographic findings with nuanced insights into the interplay between sound, memory and identity.

Overall, the findings of this research highlight the role of culturally significant sounds in evoking memories and emotional responses, positioning soundscapes as key elements in preserving Mani’s cultural heritage. The study underscores the potential of sound to act as a bridge between individual memories and collective identity, supporting the acoustic preservation of a community’s heritage amid societal change. This methodology, blending ethnographic insights with sensory and physiological data, offers a comprehensive approach to understanding the deeper meanings embedded within acoustic heritage and provides valuable implications for future ethnographic and Acoustic Ecology studies.

1.5. Landing: Key Insights on Sound, Memory, and Identity

This study has aimed to interweave the sounds, memories and sensory perceptions of Mani’s community, illustrating the deep connection between natural sounds—especially those of water—and cultural memory. The sound of the sea, the soft rhythm of sheep bells, the steady chiselling of stone and the timeless toll of church bells resonate with more than just auditory familiarity; they reflect a complex tapestry of place, identity and shared history. Through the physiological responses recorded during soundscapes and the personal stories shared by participants, a poignant picture emerged of how these sounds evoke powerful emotions, a sense of connection and a deep awareness of the environment. For participants, these recordings did not merely reflect sounds from their surroundings; they became extensions of Mani itself, giving shape to the memory and sentiment that connect the community to its land.

In engaging participants in the practice of recording their own surroundings, we found that these participant-made recordings carried meanings that transcended the technical aspects of sound preservation. Each recording session became an act of shared memory-making, offering a unique opportunity for the community to engage in reflection on their heritage and environment. For some, these recordings were meditative, for others, they served as powerful reminders of past experiences. These sounds, enriched with memory and sentiment, became shared tokens of community belonging, building bridges between generations and reaffirming their connections to Mani.

1.5.1. Implications for Future Ethnographic and Sound Studies

While the contributions of this study may only add one part to the larger dialogue in ethnography, sensory studies and acoustic heritage preservation, we hope that these insights can be of value in understanding how sound connects people to place and past. By focusing on sound as both a method and a subject, we sought to present an ethnographic approach centred around personal experience and a process-led exploration. The implications

of this work may extend beyond the Mani area, offering insight for other Mediterranean or rural regions also navigating changes brought by modernity, migration and urbanisation. These findings underscore that recording and preserving soundscapes can serve as a powerful method to reinforce communal bonds and foster environmental stewardship.

The study may further suggest that, in regions where heritage preservation often prioritises visual and structural aspects, soundscapes hold a unique place as living archives of cultural memory. This approach encourages an inclusive, human-centred view of ethnographic documentation that places the experiences, voices and stories of communities at its heart. The sensory responses and physiological engagements observed throughout the study also speak to the rich sensory landscapes that frame daily life and create lasting bonds between people and place. In considering the Mani’s sounds not only as cultural artefacts but as active parts of lived experience, the study may offer a gentle reminder of the power of sound to help preserve the intangible connections that anchor communities to their history, even amidst change.

1.5.2. Looking Forward

There are numerous paths to explore in sound-based ethnography and multisensory research. Future studies could expand on the approach by incorporating other sensory experiences—such as visual, tactile and even olfactory elements—that further reveal how people experience and preserve their cultural memory. Additionally, physiological and cognitive responses to soundscapes could be studied more closely, exploring how responses shift across generations, communities and settings. Such studies could offer valuable insights into how modern and traditional soundscapes interact with individual memories and identities, perhaps even across differing social and cultural contexts.

In advocating for the use of technology alongside traditional ethnographic methods, we remain cautious to emphasise that these tools are not the essence of the study but rather aids in preserving and interpreting acoustic heritage. Future work could pursue an interdisciplinary approach, merging scientific and creative methods to interpret soundscapes in ways that foster community engagement and environmental awareness. Above all, this study celebrates listening itself—a practice that, while quiet and unassuming, helps us to understand honour and sustain the landscapes we cherish. In the end, the act of listening, as practised here, becomes a vital means of turning soundscape into a form of heritage, ensuring that the voices of Mani’s people continue to resonate long after they have been heard.

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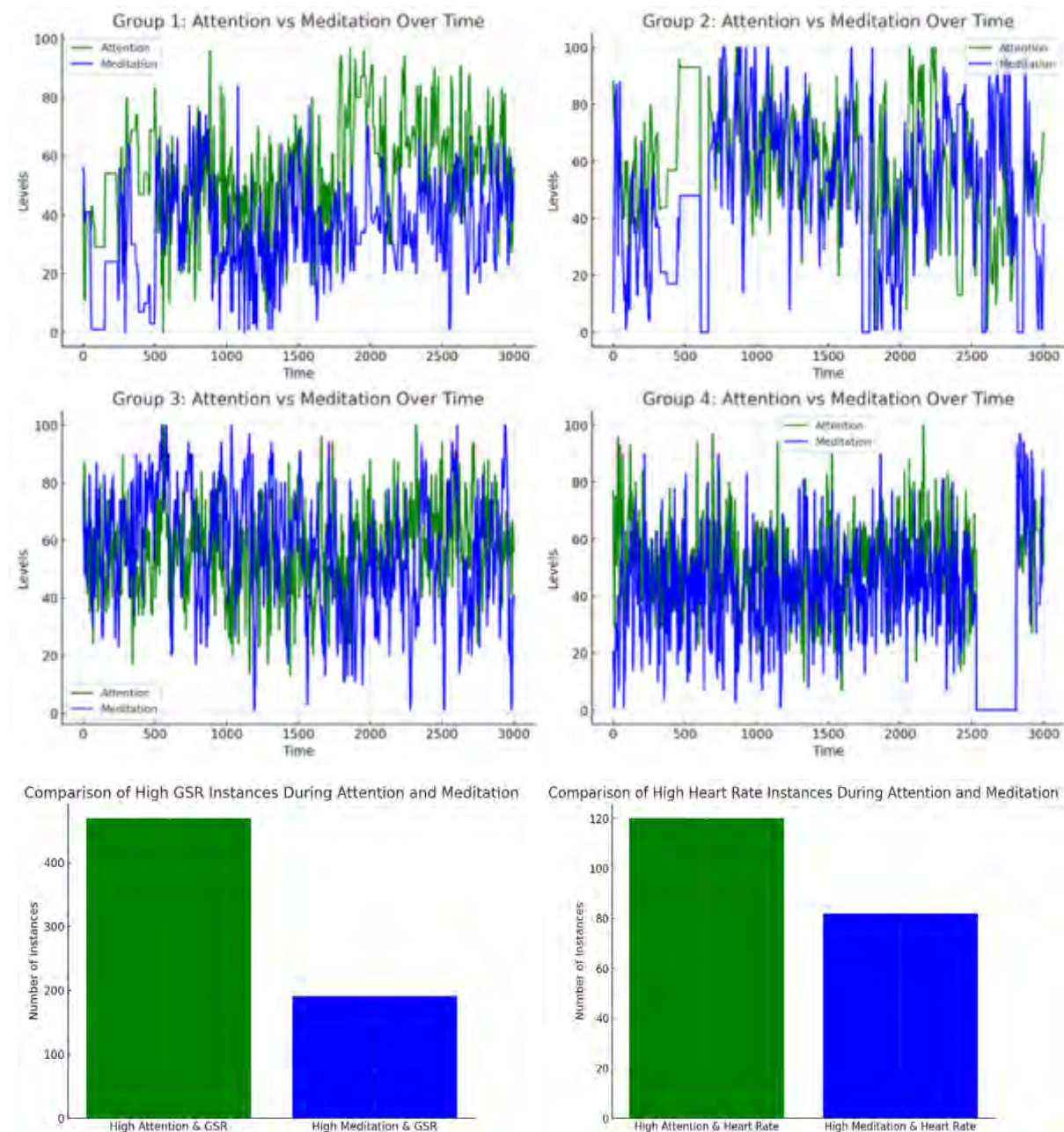
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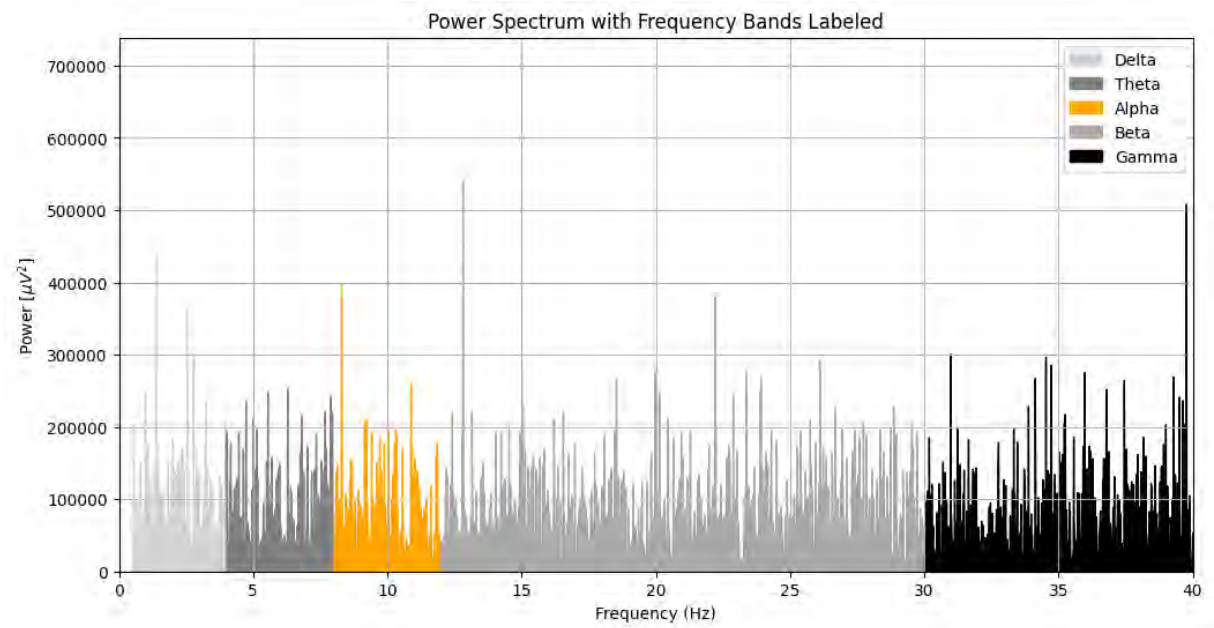
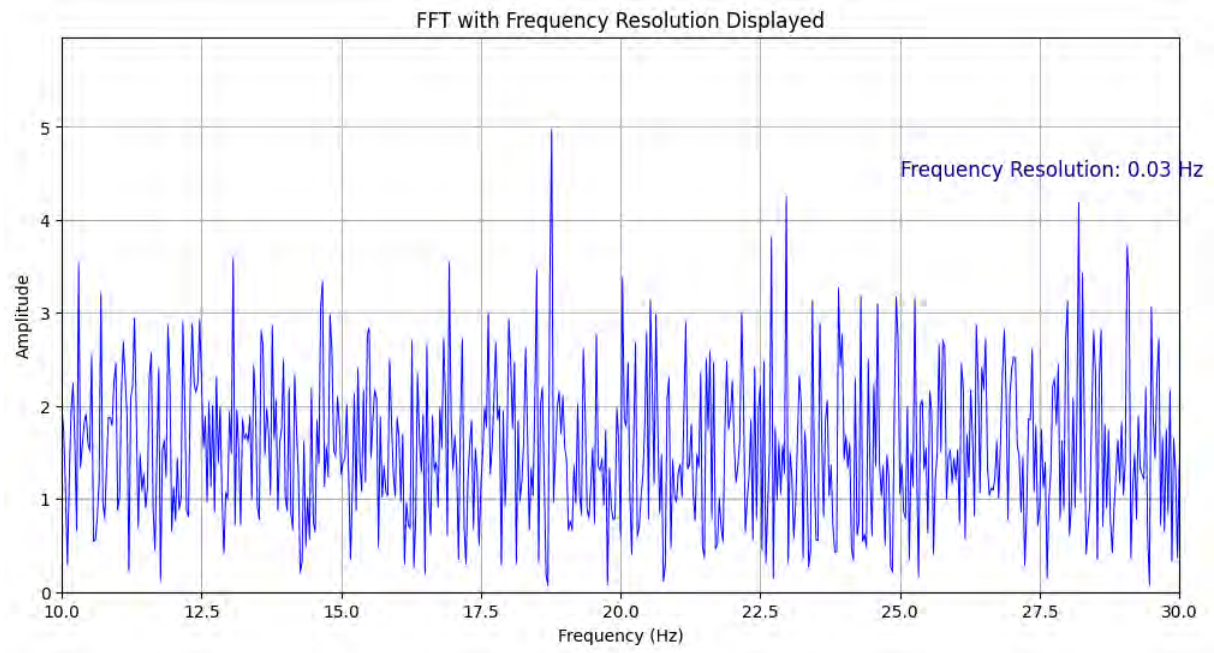
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Annexe, Tables







Keynote I

Becoming-insect in music and sound art. Some examples and questions

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Abstract

In his book Sounding the Limits of Life: Essays in the Anthropology of Biology and Beyond, the cultural anthropologist Stefan Helmreich shows that biologists can now, thanks to technological progress, perform the feat of listening to other-than-human entities such as digital life forms, microbes, coral reefs, whales, seawater, extra-terrestrials, tsunamis, seashells, and bionic cochlea. While several peoples may have been listening to the earth long before technology came on the scene, technological and scientific progress has nonetheless allowed us to go beyond anthropocentrism. The border between this development and ecological thinking will surely be in the definition of the living and the notion of life – especially in the question of whether it is possible to talk about 'digital life'. In this conference, we will discuss the 'becoming animal' – that many thinkers of ecology are calling for (David Abram, Becoming Animal: An Earthly Cosmology) – in music and sound art (with the examples of Iannis Xenakis, Hildegard Westerkamp, Agostino Di Scipio, David Dunn and Jana Winderen), through the shift from the 'becoming bird' of traditional musicians to the 'becoming insect' of many sound artists and today musicians and its relationship to the use of technology.

Keywords

Becoming insect in music

1. Becoming-insect in music

In her piece *Cricket Voice* (1987), Hildegard Westerkamp, writes:

'Cricket Voice is a musical exploration of a cricket, whose song I recorded in the stillness of a Mexican desert region called the 'Zone of Silence'. The quiet of the desert allowed for such acoustic clarity that this cricket's night song – sung coincidentally very near my microphone – became the ideal 'sound object' for this tape composition. Slowed down, it sounds like the' (H. Westerkamp's website).

Acoustic ecology has succeeded in striking a fine balance between aesthetic and ecological (environmental) concerns. In Westerkamp's case, we are dealing with works of music that are almost traditional (thanks in particular to her mixing and her development of form over time) and, at the same time, ecological positions (she writes: 'I am interested in addressing cultural and social concerns in the musical idiom. That's why I use environmental sound and language as my instruments. [...] I consider myself as an ecologist of sound', H. Westerkamp, 1985). With *Cricket Voice*, we could suggest a 'becoming-insect' of music, which is both an environmental concern (making us listen to the insect of a desert) and an aesthetic question (the 'musical exploration of a cricket' mentioned by Westerkamp).

Becoming-insect. Music has always listened to non-humans, notably thanks to its long tradition of 'musician' birds, from the whistles of the Kalulis that Steven Feld lets us hear in his recordings (1991) to the music of François-Bernard Mâche (1998) and beyond. But it would seem that becoming-insect has replaced or complemented becoming-bird. Gilles Deleuze and Félix Guattari (1980) had already noticed this in *A Thousand Plateaus*. In the modern era, where subjects become 'molecular', 'the reign of birds seems to have been replaced by the age of insects, with its much more molecular vibrations, chirring, rustling, buzzing, clicking, scratching, and scraping' (*ibid.*: 308). So, 'a becoming-insect has replaced becoming-bird [...] The insect is closer, better able to make audible the truth that all becomings are molecular' (*ibid.*: 308). I will attempt to illustrate this becoming-insect with a few examples.

2. Some examples in music

I would first like to focus on Xenakis. As commentators and listeners have often noted, cicadas or crickets can sometimes be heard in his music. This is the case in his electroacoustic masterpiece *La Légende d'Eer*. Music from the polytope that Xenakis called *Diatope*, *La Légende d'Eer* is a very long piece, lasting around 45 minutes. It unfolds like a cosmogony. The music arises from nothing, amplifies and reaches several peaks with extraordinarily intense sound activity, then slowly disappears into nothingness. We can listen to the end of the piece while comparing it with the composer's hand-drawn montage diagram.

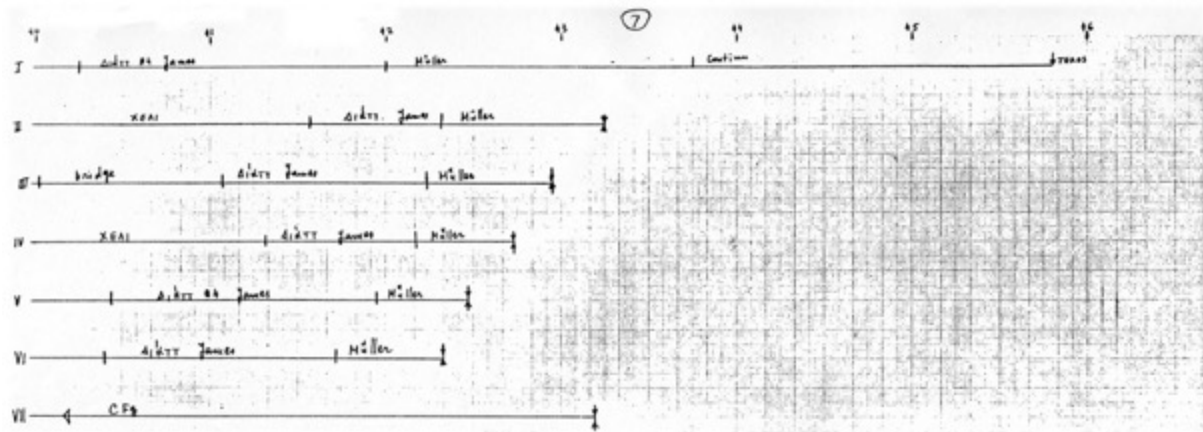


Figure 1. Iannis Xenakis. *The Legend of Eer*: assembly diagram for the seven tracks (manuscript): end

The excerpt began at 42'30, just before the end. Track 7 remained, with transformed double bassoon sounds ('C Fg' on the diagram), while crickets sang on several tracks, with only one remaining until the end. The cricket sounds are named 'Διάττ' by Xenakis, meaning 'Διάττοντες' (shooting stars) – suggesting that Xenakis may not have been thinking of crickets at the outset. I am not sure about the source of these sounds, whether they are concrete or electronic. Xenakis composed this piece at the WDR (Westdeutscher Rundfunk) studio in Cologne in 1977. He brought with him many sounds, including concrete sounds (which he uses in other electroacoustic pieces) and some electronic sounds synthesised at CEMAMu. Some of the sounds, which are more electronic in nature, had to be produced on site. This is evidenced by the references to 'James' and 'Müller', which are the names of the two studio technicians: Volker Müller and James Whitman, first and second technicians respectively. They undoubtedly gave their names to the electronic transformations of the 'Διάττ' sounds. As for the initial state of the 'Διάττ' sounds, they may be the same sounds as at the beginning of the piece, to which Xenakis gave their poetic name. If they are indeed the same sounds, at the beginning of the piece he calls them 'barre métal' for 'metal bars', so they would be concrete sounds. But this remains to be verified.

Another striking example of cicadas can be found in Xenakis' orchestral piece *Pithoprakta*, a piece often cited as the first time Xenakis used probability theory. It is a section that begins in bar 60 with sustained string notes and a xylophone solo. Towards the end of the passage, before moving into glissandi, a few string instruments repeat pizzicato notes in the high register: these are the sounds of cicadas! Figure 2 presents the score. There are many recordings of *Pithoprakta*. The one produced by the Luxembourg Philharmonic Orchestra conducted by Arturo Tamayo (2008) is probably the best, but for this extract, I suggest to listen the version released in 1965 by Chant du Monde, with the ORTF (French radio) national orchestra conducted by Maurice Leroux, because it is played faster.

Figure 2. Iannis Xenakis. *Pithoprakta*: measures 77–90: score

In terms of insects, the most striking passage in *Pithoprakta* is found in measures 122-171 (figure 3). In this passage, Xenakis superimposes six groups distinguished by their playing techniques: short arcoss, col legno strikes, col legno glissandos, arcoss glissandos, pizzicatos, and noises resulting from the hand striking the body of the instrument. There are up to 46 actual parts (each string instrument plays its own score), resulting in an impressive overall mass. In certain passages, Xenakis asks for particular groups of timbres to be brought out, indicating, as in bars 125-127 for the short arco group: 'In this nebula of sounds, bring out the galactic configurations of the "arco norm. ff" bow strokes'. Nouritza Matossian found the perfect metaphor for this passage, writing: 'It's like a war in the insect kingdom. You hear a buzzing, a humming, a murmur, pierced by high-pitched cries [...in] an intense movement on a tiny scale' (Matossian, 1981: 118). If we adopt this metaphor, we can imagine the process of highlighting a particular group as observing a specific region of this incredible microscopic life under a microscope.

W.B. V.I V.II V.III B. P.

arco brefs short bows

122 123 124 125 126 127

■ Dans cette nébuleuse de sons faire ressortir les configurations galactiques des coups d'archets "arco norm. ff" des instruments notés ■.
In this nebula of sounds, the galactic configurations of "arco norm. ff" preceded by the sign ■ must be put in relief.

S.A.H. 19583

Figure 3. Iannis Xenakis. *Pithoprakta*: measures 122–127: score

With these examples, one might think that Xenakis indulges in a naturalistic aesthetic, his sound masses representing and imitating the sounds of insects. But I think this analysis misses the point. Because he works with sound masses and noises, Xenakis immerses us in soundscapes that sound like insects. He rejects classical naturalism: for example, commenting on the visual spectacle of his *Polytope de Cluny*, in which light effects are created using hundreds of spotlights, and which has often been seen as a depiction of starry skies, he writes that he isn't trying to 'recreate nature [...] The starry sky is far more beautiful than my clouds of flashing lights' (I. Xenakis, 2002). Also, he stresses the importance of the abstract dimension rather than the aesthetics of representation. He seems to take pleasure in becoming one with the wild, disordered and unpredictable nature in which his music is interested. His aesthetic could thus be defined as Dionysian: his aim is immediate expression achieved through fusion with nature. (This may explain why at the end of *La Légende d'Eer* we hear crickets while Xenakis notes shooting stars, because the specific elements are not important; what matters is the process of immersion and fusion). Taking up an old debate in the fine arts, we could say that Xenakis is actually breaking down the idea of representation by insisting instead on presentation. Some listeners have a rather prudish reaction to Xenakis' work, a reaction that they disguise by describing the work as simplistic because it 'evokes' natural phenomena rather too straightforwardly. This embarrassment comes precisely from the fact that these phenomena are not evoked or represented, but that in a strange way, they have erupted into the music! His works act 'immediately', without passing through the mediation of language, figuration or codification: they provoke physical shocks. In a way, we could place Xenakis among the ranks of the pioneers of environmental music (cf. K. Paparrigopoulos, 2015). And that is why Deleuze and Guattari's expression 'becoming-insect' suits him so well – even more so when we consider the fact that his masses present themselves as masses of molecules (probability theory).

The same applies to other contemporary musicians. Perhaps, for example, with Salvatore Sciarrino, when he says: 'By listening to reality with the ear of an insect and the ear of a giant, I try to reproduce it in music made of wind and stone. These are listening experiences which, more than any others, could be defined as ecological (Sciarrino in Vinay, 2005). I am also thinking of the music of my friend Agostino Di Scipio, whose work on granular synthesis (and silence) sometimes brings out – in the cognitive science sense – virtual insects or even birds (cf. Meric and Solomos, 2014), for instance in his piece *Due di uno*, for violin and electronics.

In the field of free improvisation, referring, like Di Scipio, to complex systems theories, David Borgo theorised collective improvisation as 'insect music', comparing it to the 'swarm intelligence' that scientists are studying today. 'There are several ways in which we could make the connection with the swarm. Some improvised music provokes such rapid reactions in instrumentalists and evokes such complex and dense soundscapes in listeners that a literal analogy with a swarm of insects seems appropriate', he writes. Or also: 'The idea that music can be organised in a complex way without a composer or conductor still leaves many people in doubt. [...] But the emerging field of SI [swarm intelligence] demonstrates that complex behaviours and effective solutions can arise without a leader, organised without an organiser, coordinated without a coordinator' (Borgo, 2006; see also Borgo, 2005).

3. Environmental ecology and field recording

It is of course among composers who refer to ecology that the becoming-insect is sometimes generalized, as the following three examples show. The work of David Dunn, the American sound artist inspired by deep ecology, is well known. His 2006 CD *The Sound of Light in Trees* makes us hear sounds produced within one species of conifer tree, the common two-needle pinyon of the southwestern United States, *Pinus edulis*. All of these recordings were made with a custom-built vibration transducer inserted between the outer bark and the interior phloem where the bark beetles attack and colonise. 'Even though these sounds are extremely low in amplitude, they are transmitted as vibration across the interior surface of the bark structures for quite a distance' (Dunn, 2006). Dunn adds:

'I first began to focus my attention on these trees and their principal invaders (Ips beetles) as the demise of the pinyons where I live in northern New Mexico became quite evident [...] In recent years, whether due to local drought conditions, global climate change or other factors, bark beetles have outstripped the capacity of the trees to defend themselves and we are witnessing an extraordinary level of infestation' (*ibid.*).

I will simply mention several other musicians and sound artists who are working in this direction: the duo Sabine Schäfer and Joachim Krebs with their *TopoSonic Sheres* (2004), Rodolfo Caesar's *Círculos Ceifados* (cf. J. Svidzinski,

A. Bonardi, 2016), jazz clarinettist David Rothenberg, who likes to improvise in the presence of animals and who has carried out a project with cicadas (cf. D. Rothenberg, 2016), Pedro Filho Amorim's *Entomúsica* project (2021)³¹.

The work of the Norwegian artist Jana Winderen, who focuses on audio environments and ecosystems which are hard for humans to access, both physically and aurally, is beginning to be more widely known. *The Listener* (2016, cf. Figure 4) is a sound composition created from hydrophone recordings made in the River Orne in Normandy as part of a three-year investigation into the health of the river: 'Freshwater biologists count underwater insects and use this data as an indicator of the water's health. If we can identify the sound of specific underwater insects with their varying ability to survive forms of pollution, it is possible, through focused listening, to reach an understanding of the health of the river' (J. Winderen 2016).



Figure 4. Jana Winderen, *The Listener*. Illustration by Jana Winderen. Published by kind permission of the author

4. Some questions

In conclusion, I would like to briefly ask a few simple questions, namely: why this insect-like evolution of music (and sound arts)?

Deleuze and Guattari referred to the fact that evolutions had become molecular. By this metaphor, they meant that identities should be broken down and fought against when they present themselves as large, solid, immovable blocks – blocks that give rise to identitarianism, fundamentalism and fascism, as we know – in favour of greater fluidity: the 'subject' must be replaced by (multiple) processes of subjectivation. Hence the metaphor of the insect which, unlike the bird, appeals to a smaller and more fragmented scale, as its sounds make very clear to us.

Moreover, birds, at least in the music of the past, are perhaps too 'beautiful', preventing any critical thinking except in the form of nostalgia. They take us back to a time – more precisely: in order to be heard, they need this time – that is mythical, prior to humans or, more simply, without anthropogenic sounds. Here we should question the great tradition of 'musician' birds. This tradition is linked to the aesthetics of imitation. However, this

³¹ For further reading on the insectification of music, see the recent anthology edited by A. Montandon and B. Lassauzet (2022). I also refer you to the company 'Les insectes' founded by Bastien David, which focuses on the 'circular metallophone': 'Insects, these little creatures or bugs, constitute the reality of an imperceptible and interconnected world, too often ignored and yet indispensable. Taking the time to look at them with kindness allows us to appreciate the complexities and beauties that emanate from these tiny lives. The colours and sounds we perceive from these small worlds are an inexhaustible source of inspiration for me. By playing the circular metallophone, the musicians of the company 'Les insectes' will immerse us in the iridescent universe of the sound of the infinitesimal, thanks to the microtonal tuning of this new instrument', writes Bastien David (n.d.).

aesthetic developed as human societies moved towards the domination of nature. Mimesis is in step with the history that leads to the outright domination of nature: when viewed through the lens of representation in art (perspective in painting or solfeggio and tempered writing in music), nature is indeed a dominated nature, reinvented from scratch. At the same time, this theory of imitation gives art a unique role: unlike technology, art takes it upon itself to remind us of the (disappearing) existence of nature. It is the place where nostalgia for nature can be expressed, and perhaps even protest against the reification of the world. Theodor Adorno clearly highlighted this role of art in its relationship to natural beauty as nostalgia (and promise) for the non-identical, the non-human (Adorno, 1970: 103-104). Imitating birds, as Vivaldi or Messiaen do, is both a tribute to them and a way of caging them. We are in the realm of naturalist aesthetics.

In order to develop, ecological thinking needs to rid itself of this aesthetic, so that it can forge real, material (and not just symbolic) links with the environment and act in its favour. Insects can help here. Indeed, they can be less aestheticised, their sounds are not always 'pretty' and, above all, it is not easy to hear them with the naked ear; we need a device to capture them and then amplify them.

In mentioning equipment, I come to a final explanation for our becoming-insect. In fact, it has been made possible by the development of technology. In this respect, musicians and sound artists are like biologists who, as Stefan Helmreich (2016: XI) shows in his book *Sounding the Limits of Life: Essays in the Anthropology of Biology and Beyond*, can now, thanks to technological progress, perform the feat of listening to other-than-human entities such as digital life forms, microbes, coral reefs, whales, seawater, extra-terrestrials, tsunamis, seashells, and bionic cochlea (and, of course, insects, I would add). Technology? In fact, we can only hear the insects of David Dunn or Jana Winderen thanks to technology. This introduces a new problem, that of mediation. If we can only hear insects through technical mediation, we are dependent on it. Is ecological thinking compatible with this dependence? The boundary between the development evoked by Stefan Helmreich and ecological thinking will undoubtedly lie in the definition of living beings and the concept of life – in particular, is it possible to talk about 'digital life' as he does?

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A watercolor illustration of a dark bird perched on a branch, with the text "Acoustic ecology and Soundscape ecology" overlaid. The bird is dark with a white eye and is perched on a thin branch. The background is a light, textured wash of colors, suggesting foliage and sky. The text is in a bold, black, sans-serif font.

Acoustic ecology and Soundscape ecology

Some Notes on an Ecology of Time

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Abstract

Acoustic ecology is typically concerned with sound and listening located at specific sites where the focus of attention is the auditory phenomena themselves. The ecological perspective thus seeks to explore the consequences of the presence, absence and co-existence of auditory phenomena as evidence of the evolution of a specific stratum of lived existence. This paper will focus on the temporal aspect of sound phenomena, exploring the ways in which sound embodies time, and proposing that sound phenomena create time as a specific set of relational properties with meaning. This implies that the ecology of sound creates a parallel ecology of time, with consequences for the perception and experience of living beings. The paper will explore the ecological niches of time, and discuss the evolutionary pressures evident in shifting experiences of time through sound.

Keywords

Time, ecology, interaction, construction of time, birdsong

1. Introduction

Time appears through sound: from the structural domain—between periodicity and aperiodicity—that maps out sonic qualities, through the temporal envelopes of frequency and loudness that alert and shape our perception, to the moments of occurrence of specific sounds in specific places as registered in the early and defining texts of acoustic ecology (WSP 1977). Time appears, but I hope to show also that time is actively constructed by sound. Although time is often discussed in metaphysical terms, I want to approach it from a more pragmatic and materialist standpoint that emphasises its relational, rather than its durational properties.³² Consequently, this discussion is going to start from the premise that—for living selves—time is both constructed and meaningful. As Henri Lefebvre (2004) and Albert Einstein (1905), in their different ways, have pointed out, time is a social phenomenon: that is, it appears through and depends on relationships between both living and non-living entities - between, for example the coincidental observation of an event and a clock. Lefebvre, in his late work *Rhythmanalysis*, proposes a study of the temporal effects of social regularities, and his remark that 'Everywhere where there is interaction between a place, a time, and an expenditure of energy, there is rhythm' (Lefebvre 2004: 15) provides an important insight into the connection between sound and time. Rhythm is often treated as an internal property of something, but for Lefebvre it concerns the interactive processes and social consequences of temporal intra-action. Associated with rhythm, the phenomena of synchrony and entrainment, evident in many instances of sonic production across the human and the more-than-human worlds, can be seen as a tendency—even as a sort of 'gravitational' tendency—towards temporal relationship between both living and non-living entities that is foundational for the ways in which time gets constructed and comes to have meaning. I will argue that sound, as an inevitable outcome of the interaction of the fundamental forces of nature, within the environment of planet earth, is itself a primary and defining force in the construction and maintenance of a set of time properties and relations that form an environment, with ecological implications for human personal and social lives, as well as for the lives of the other beings with whom we share the planet. This brings another form of specificity to the practices of acoustic ecology, attempting to show that sound, and the lived experience of it, provides a milieu for the temporality of our existence that substantiates the relational and meaningful properties of time in ways that are subject to all of the ecological pressures that arise through the evolving interactions of the forces and actors that constitute the current milieu of planet earth.

³² This approach is based, in part, on Gaston Bachelard's critique of the philosophy of Henri Bergson. See for example (Bachelard 2016 [1950]).

1.1. Time-scape

The claim here is that there is a sort of ‘ecology’ of time, a time-scape, which arises because of the ways in which time is meaningful for living selves. This discussion will consider some of the different aspects of this ecology, particularly in relation to the consequences of living in the age of the Anthropocene, when rapid changes in the life dynamics of planet earth have introduced a set of temporal pressures that affect the possibilities available within constructed and meaningful time. In order to refine the sense in which we can view time as constructed, it is necessary to distinguish between those temporal constructions that are in some sense innate to living beings, and those which are learned and thus malleable. The innate part of time construction comes in the notion of circadian time, which is a temporal regularity defined by so-called *zeitgebers*. These are phenomena which articulate lived space, particularly planetary motion around the sun with its consequent regularities of contrasts between light and dark, although other possible *zeitgebers* include temperature, humidity, electro-magnetic flux, and other things. (cf. Harpole and Cassone 2021) *Zeitgebers* are definitional, in the sense that they have a power over living organisms that is hard-wired and difficult to change. Thus, human cycles of sleeping and waking are regulated by circadian time constructions that instantiate a relation between planetary motion and hormonal variation in a living self. It might seem that sound is not a part of this system, and yet a phenomenon such as the so-called ‘dawn chorus’ for birds in particular, but also other animals in the tropics, is a sonic event—circadian in motivation—which constructs a set of temporal relationships. There are several aspects of this particular phenomenon that are worth exploring, but first I want to introduce the idea of the so-called ‘weak *zeitgeber*’, a pressure on time construction that comes in between the definitional circadian cycles and learned social interactions.

1.2. Weak *zeitgebers*

The start time for the dawn chorus seems to be dependent on a number of factors. According to a recent study by Adrianna Bruni and colleagues, ‘Overall, birds began singing earlier with full or third quarter moon (when moonlight is present at dawn) and with increasing temperature at nautical twilight, and birds began singing later with the presence of cloud cover and precipitation.’ (Bruni et al 2014: 877) Cloud cover and temperature thus act as weak *zeitgebers*, providing timing cues that nudge a temporal construction otherwise prompted by the circadian cycle. Planetary motion is not changed by the consequences of the Anthropocene, but temperature, cloud cover, and precipitation may be. Indeed, as we have seen recently in Scotland and in Central Europe, temperature fluctuations influence patterns of cloud cover and precipitation that are changing dramatically, as zones of low atmospheric pressure become trapped in over-heated zones of high pressure. In the variations presented in the start time of the dawn chorus, changing patterns of temperature and cloud cover can be seen to affect time relations. However, sound itself can also act as a weak *zeitgeber*, and anthropogenic noise—a clear attribute of the Anthropocene environment—does exert temporal pressure on other species. Thus, it seems that bird populations in the vicinity of large airports alter the time of their dawn singing in order to minimise the overlap with periods of intense aircraft noise that can mask their songs. An international study by Diego Gil and colleagues found that, ‘Aircraft traffic time was the main predictor of song advancement: across Europe, those bird populations whose singing time overlapped the most with aircraft traffic were those that advanced their song timing to a higher extent. ... However, such an adaptation likely involves departing from optimal singing times, leading to higher energetic costs and amplifying between-species differences in competitive ability and resilience.’ (Gil et al 2015: 435) This last point emphasises the ways in which a set of social interactions such as are evident in the dawn chorus depends on meaningful time relationships. The dawn chorus has a temporal sequence, depending on the interactions and interrelations between different songs. Thus, in a North American context, ‘Alder flycatchers begin singing earliest ..., followed by Song Sparrows, White-throated Sparrows, American Robins, Eastern Phoebe, and Black-capped Chickadees.’ (Bruni et al 2014: 877) Aircraft noise acts as a pressure on this time ecology, prompting individual species to alter their starting times in ways that may not be optimal for their relation to other species.

This example demonstrates some of the ways in which time can be viewed as constructed, and thus subject to ecological considerations that arise through different and competing temporalities. The temporal interactions evident in something like the dawn chorus, however, are only a part of a larger time ecology that can be seen in the presence of shifting relationships between circadian patterns, the effects of weak *zeitgebers*, and learned social interaction. As with other ecological dynamics, time appears as subject to the pressures consequent on the particularities of the era of the Anthropocene. In order to investigate the ways in which those particularities

put pressure on time construction and meaning, Michelle Bastian and Rowan Bayliss Hewitt (2023) have recently drawn attention to the study of phenology. This began as citizen science, the historic recording of the daily interactions between human beings and the world around them in garden diaries. This record provides a synoptic view of the interactions between different time constructs across the disciplines of biology, ecology, and climate science. As an example of the pressures on time construction produced by the Anthropocene, Anna Lawrence's recent paper entitled "The first cuckoo in winter" (2009) references changes to the temperature patterns of the seasons which result in a temporal mismatch, compromising the time judgement of a bird whose survival depends on its presence at a moment when other birds are nesting. This mismatch also produces a change in the sound environment that is culturally confusing for humans, and one must suppose also for birds. It is a mismatch that can have profound consequences for the cuckoo's survival.

2. Phenology

Phenology draws our attention to the ways in which multi-species time constructions are entangled in ways that facilitate or compromise interaction and co-operation. As Bastian and Hewitt remark, 'Since many species initiate phenological events based on interactions with other species, phenology thus entails an (often periodic) events-based and cross-species understanding of time.' (2023: 1079) The anthropologist Anna Tsing calls these interlocking time constructions 'polyphonic assemblages ... as they result from world-making projects, human and not human' (Tsing 2015: 24). The image of polyphony is explored by Tsing in a deeply musical sense, which is not to treat it as a holistic, totalising regime, but to hold in tension the possible relations between each single part and the strands of the whole that they generate. This image sits in contradiction to industrial notions of time and motion, with their emphasis on rigid co-ordination and end-point efficiency. Phenology reveals the foundational mismatch between the time constructions of the processes of industrialised human extraction, and the time constructions of other human and more-than-human actors with whom we share the planet. In the oceans, as in cities and around airports, the sounds of the Anthropocene, and the temporal constructions that those sounds proliferate, can be seen to exert significant pressure on the polyphonic time regimes of other beings.

Bastian and Hewitt make one further point that seems important in this discussion. Just as Tsing's image of polyphony is developed in a way that is dynamic and relational, rather than totalising, so this whole discussion of time formation, with its circadian, weak-zeitgeber, and social cues, has to be understood in relation to a planet that is not uniform in its temporalities, even though it forms a whole by the relation of its parts. One only has to consider the circadian, light-dark patterns that are constant at the equator but oppositional at the poles, to understand the possible differences in time formations and time ecologies across planet earth. Bastian and Hewitt remark that there is a 'perception in the Global North of a clearer distinction between seasons in temperate regions compared to other climates' and that this has allowed a neglect of 'timing in tropical ecosystems being more diverse, responsive to a wider variety of cues, and less aligned to overarching seasonal phenomena.' (2023: 1079) Sonic cues are everywhere important, and I want to turn now to some of the social or learned interactions through sound that are implicated in the construction, use, and experience of time, and which contribute to an ecology of time in ways that are fragile.

As with humans, birds learn about vocalisation through learning. It is an innate potential that needs to be realised through a process of interaction. Since interaction is always with a surrounding world, as Jacob von Uexküll notes 'there are as many worlds as there are subjects.' (von Uexküll 1926: 70) This is a different scenario to the effect of zeitgebers, and it is constituted by a sound environment which, as Alma Farina, Alice Eldridge and Peng Li describe it, is experienced uniquely by each organism, in ways that are 'shaped by the specificity of its biological receptors and semiotic sensitivities.' (Farina et al 2021: 148) Semiosis is often regarded, in this context, as meaningful sound, but I want to extend that idea to include meaningful time. As Pierre Bourdieu remarks, in *The Logic of Practice* (1990), 'The same act ... can have completely different meanings at different times' (105), and thus time itself comes to have meaning. And he goes on to say, 'To abolish the interval is also to abolish strategy.' (106) The dawn chorus is a moment for strategy, since both territory and mating potential are at stake. In their study of the structure of the dawn chorus, Oscar Marín-Gómez and colleagues (2019) compared bird vocalisation within two different sonic environments, in inner-urban and urban peripheral settings. As might be expected, there was a marked difference in interaction strategies. The urban peripheral setting, with its fuller complement of species, showed a marked temporal structure within which the available acoustic space is filled gradually by a modular pattern where each module has a low song frequency overlap. There is a clear sensitivity to the moment at which a song occurs. The inner-urban setting, on the other hand, with its depleted species count, still shows a

modular pattern, but without temporal organisation. It is as if the birds are unsure of which moment to choose, disturbed, in the reasoning of the authors, by ‘the behavioural adjustments of species ... in response to the anthropogenic noise and artificial light levels.’ (5)

Ernst Haeckel’s foundational account of ecology proposes it as ‘the whole science of the relation of the organism to the environment including in the broad sense all the “conditions of existence.” These are partly organic, partly inorganic ...’ (quoted in Stauffer 1957: 140-141) This inclusivity emphasises Haeckel’s point that ecology is always about relationships, and in particular about those relationships that bind us into existence. What I have tried to argue here is that time is one of the key binding elements, and, as in other ecological narratives, there is a temporal environment—which I have described as being instantiated by zeitgebers, weak-zeitgebers, and learned social praxis—as well as individual, interacting subjectivities that form and maintain ecologically explicable relationships within that environment. These relationships seem to me to depend to a large extent on sound and sonic practices. In so far as time is central to the practice and experience of lived existence, I am arguing that the richness of diversity within this time ecology, which springs out of both environment and the set of relational strategies that can be developed, matters to living beings.

3. Conclusion

This brief account of the ways in which sound constructs meaningful time, has concentrated on birdsong, since those phenomena are clearly described and discussed in a wide range of historical and contemporary studies. However, we humans are also listening subjects, alert to the semiotic nuances of the time-scape in which we live, listen, and make sound. As we ponder the implications of the loss of diversity within the environment that surrounds us, we should also ponder the loss of interaction potential, not just with sound per se, but with the temporalities that sound subtends. As we construct and learn about time through our interactions, so our experience becomes impoverished, our temporal awareness and our interactional abilities become lessened without a rich and diverse surrounding of time interaction potentials and examples. This might indeed propose an evolutionary purpose for the practice of music, in relation to the sounding of the world, in terms of the instantiation and development of the sophisticated time structuring that is required by living selves. We should remind ourselves, in this moment when time in the Anthropocene seems to be pressing us, that habitat and species loss make it possible for time also to become poorer.

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Environmental Active Listening as a Form of Ecological Activism. Case Study: The Soundscape of "*Pedion Areos*"

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Abstract

It could be argued that there is a sound environmental crisis that the general population might not 'listen to it'. This study aims to highlight the problem of environmental degradation as a multi-layered phenomenon, and in this context to recognise the effects of this degradation at sound level. In this research, listening is primarily presented as a basic means of environmental awareness, but also as a medium for environmental activism. The study explores resources from the disciplines of ecology, sociology and musicology related to sound activism and political action through sound and active listening. As reference this research is based on a case study upon Pedion Areos Park in Athens, in order to discuss in more detail the importance of sound in green spaces in urban areas.

Keywords

Soundscape, sound ecology, sound activism, environmental sound, sound awareness

1. Introduction

Noise pollution that originates from humans, technology and human-made structures, is constantly growing and spreading indiscriminately, continuously burdening the lives of both humans and the animal kingdom (Volcler, 2013). This increasing malicious noise poses a significant challenge and has become the focus of many studies centered on human well-being. Extensive research is also being conducted on the physiological effects of noise (Warren, Katti & Brazel, 2006; Szpunar, 2020). However, the need for reconnecting humans with nature is often neglected.

Neither natural soundscapes, nor nature itself seem to be a priority for humans. The presence of constant background noise has almost become an inherent need for modern humans (Makomaska, 2019), while quiet (or peaceful) areas have almost disappeared (Payne & Neil, 2019). Human-made noise has dominated most of the sound sphere, making it essential to understand the importance of soundscapes, mutual respect among humans and respect for other beings (Jeziński & Lorek-Jezińska, 2020). If humans seem indifferent to their environment, how can they realise the erosion the natural soundscape has undergone?

Could listening to soundscapes and nature help to underline this issue and make it evident? By actively engaging with their auditory environment, individuals may develop a greater awareness of the sounds around them and their impact on their well-being. Auditory explorations of soundscapes could provide a pathway for individuals to reconnect with nature, fostering a sense of respect and care for the environment.

2. Theoretical Framework

2.1. Sound as a Bridge: Sound Art for Environmental Action

Sound serves as a vital link between humans and the natural environment, enabling a deeper understanding of the relationship between soundscapes and the destruction caused by human activity. Bioacoustics and Soundscape Ecology use sound to detect biodiversity and record the impacts of environmental changes caused by human activity (Louro et al., 2021, p.8). As Krause (2002, p.6) states, "to understand the natural world, we

must perceive the sound that emerges from every ecosystem", emphasizing that humans and nature coexist within the same interconnected ecological system.

Sound functions as a bridge between the human and natural worlds, offering insight into the degradation caused by human activity. Through the sensory qualities of sound, humans are anchored to specific temporal and spatial realities, fostering a deeper emotional and intellectual connection to the environment. Just as scientists use sound to understand ecosystems, artists can use sound in their creative practices to raise environmental awareness. Artists, in particular, have a unique ability to leverage this connection, playing a pivotal role in addressing the climate crisis (Barclay, 2019).

Although climate change, as Boulton (2016) suggests, may exceed the boundaries of our current cognitive and sensory capacities, art—especially sound-based art—has the potential to transcend these limitations. To transcend these perceptual limitations, artistic strategies must move beyond representation and engage the audience in multisensory, embodied, and affective experiences. By drawing attention to environmental degradation, it can mobilize awareness and inspire action. In this context, sound becomes more than just a passive medium; it transforms into an active force for change, capable of stirring consciousness and compelling society to confront the urgent realities of the climate crisis. Through creative exploration, artists can channel the power of sound to foster a renewed sense of responsibility for the preservation of the planet, encouraging both emotional connection and active engagement with environmental issues.

2.2. Acoustic Awareness and Environmental Preservation

The connection between listeners and the endangered environment is crucial to understand as it properly informs people about the world they live in (Brzostek, 2020). Truly understanding the environment requires attention and sensitivity—qualities often neglected, as many fail to reflect on how and what they hear. This lack of consideration contributes to widespread indifference toward the climate crisis. Yet, auditory awareness or empathy alone is insufficient to cultivate a "sustainable and meaningful relationship" with nature and the environment (Louro et al., 2021).

Thoughtful planning of sound interventions and practices is essential to make a meaningful contribution to the planet's preservation. In the works of Labelle, Tonkiss, Westerkamp and Bruce Smith, there is a concerted effort to inform audiences about the increasing need to link social and cultural research with Acoustic Ecology (Droumeva et al., 2010, p.30). This connection aims to expand the concept of anti-noise activism—a movement that opposes noise pollution and advocates quieter, more mindful environments (Droumeva et al., 2010, p.30). As Kapelański (2008) points out: Schafer called for the transformation of the polluted soundscape into a more ecologically compatible one, based on the criteria and ideas of Acoustic Ecology.

Participatory and political practices encourage listeners to take an active role in environmental protection. Active listening offers the possibility to raise awareness through the acoustic environment to nature (Rebelo & Velloso, 2018). However, this requires a "responsible listener"—someone who actively engages with listening rather than consuming sound passively (Ramos-Kitrell, 2021). One of humanity's most powerful tools is not merely the ability to hear, but the ability to actively listen and respond. Active listening, in this context, becomes a form of activism: it enables individuals to attune themselves to the social and environmental conditions that often go unnoticed or unheard. Whether through participatory sound walks, community-based ecological projects, or soundscape mapping, listening becomes a political and ethical act — a way of bearing witness and fostering engagement (Louro et al., 2021).

2.3. Listening

According to Acoustic Ecology, both activism and education play a crucial role in fostering a more attentive listening culture within society. Listening is a vital perceptual skill, equal in significance to sight or touch, as sound is continuously produced by movements, actions, and natural processes. Even in seemingly quiet environments, absolute silence is almost never present; rather, the world is filled with subtle acoustic signals that carry essential information about our surroundings (LaBelle, 2010; Tiaux & Barrett, 2011). Cultivating the ability to perceive and interpret these sounds is fundamental to reconnecting with the environment and deepening ecological awareness. However, from modernity onwards, human senses seem to have dulled, causing us to often passively receive sound without actively paying attention to it (Louro et al., 2021). Yet, as Brzostek (2020) argues, the practice of intentional listening can awaken a new sensitivity, fostering a greater sense of care for the acoustic

environment. By cultivating a culture that values listening, ecological activists can promote environmental stewardship. This will be enhanced by listening because "listening, or self-listening, is in itself a practice based on different attention, presence, and perception of the external environment, especially in a culture dominated by visual stimuli" (Jeziński & Lorek, 2020).

Yoganathan (2021) highlights that listening is a "politically radical gesture". We must listen, comprehend and act upon what we hear. Just as freedom of speech exists, so does the freedom of listening, which demands an "active responsive stance" that enables the expression and reception of diverse voices and perspectives (Labelle, 2018). By developing the ability to listen, individuals also gain the capacity for meaningful dialogue and action. Listening is not a passive act; it is an active engagement that fosters responsibility, comprehension and response, making it a crucial force for change and environmental protection.

Moreover, technology can aid in listening to nature, helping to awaken public awareness. An example is the installation *Tree Radio* (2015), which allowed individuals to listen to trees responding to their environment using photo-sensors (Hall, 2015). Such art installations seek to raise awareness about the condition of ecosystems while also offering a peaceful space where people can find solace in natural sounds (Holmes, 2022, p.34). It is crucial, however, that these installations, which aim to draw attention to the natural world, align with the ethical considerations inherent in creative acts. In this context, ethical consideration entails a mindful approach to artistic practice—one that acknowledges the potential environmental consequences of creative interventions and seeks to uphold respect for non-human life.

3. Research

3.1. Towards Ecological Consciousness: Sound, Activism, and the Role of the Humanities in Climate Engagement

Experts from various fields highlight the need to "ecologise" the humanities and incorporate a political ecology to safeguard a sustainable future for all life on Earth (Reich, 2018). The public's limited ecological sensitivity, often influenced by humanity's self-destructive tendencies, aggravates this challenge. Szpunar (2020) also discusses the absence of certain kinds of "climate science" that could strengthen the bond between humans and the environment. The persistence of "climate denialism"—a complex of psychological mechanisms that reject the harmful realities of climate change and the destructive role humans play—is a central issue (Szpunar, 2020). While environmental degradation is recognized, the lack of meaningful reaction allows these issues to persist, even as mysterious disruptions in ecosystems, driven by climate change, continue.

Acoustic Ecology adds a new dimension to the search for solutions, advocating for a deeper understanding of environmental crises through the act of listening (Droumeva, 2019). For instance, Vandsø (2020) argues that listening itself can foster a shift from the negativity surrounding climate change toward a more hopeful, proactive engagement. Environmental sound art, such as the work of Barclay (2019) and Gilmurray (2021), can spark this change by immersing audiences in ecological soundscapes. Such activism, aimed at "disrupting the status quo", plays a pivotal role in stirring political action (Duncombe, 2016). Political art, as Duncombe (2016) suggests, is most effective when it engages personal expression, allowing individuals to act wholeheartedly and collectively. Civic activism, as defined by Duncan Green, involves individual efforts with social consequences, often requiring collective action, since true change comes from people initiating efforts to create an impact by themselves (Duncombe, 2016; Goris, 2017).

Over the past two centuries, sound has evolved into a potent tool for both expressing power and suppressing dissent (Saher, 2016). Activist actions, especially in the arts, can address social tensions and liberate community dynamics, enhancing well-being (Farinati & Firth, 2017). In general, all types of sound art incorporate an environment, as the reproduction of the artworks takes place in a space that responds to the entire compositional creation (Holmes, 2022, p.30), thus making the importance of space clear. These inventive actions have the potential to drive change, yet the challenge lies in overcoming the disconnect between problem awareness and concrete action. For instance, soundscape projects offer individuals—both artists and listeners—a sense of personal engagement and action (Reich, 2018).

Bernie Krause, who calls for the preservation of natural soundscapes, indirectly emphasizes activism through the care for disappearing acoustic environments (as cited in Thompson, 2022). This notion of care—as a form of activism—also appears in the work of Joan Tronto, as referenced by Brzostek (2020), who highlights care as a political and ecological responsibility, oriented toward the restoration of the world we inhabit. Brzostek (2020)

further explores Krause's ideas, pointing out the techniques and actions essential to this care, such as attentive listening, field recordings, and soundscape artwork. This heightened awareness naturally leads to a greater sense of responsibility and care for the environment (Reich, 2018, p.40). These methods encourage a deeper understanding of our environment, fostering both individual and collective responsibility for its protection.

In conclusion, motivation and inspiration can drive the response to climate change. Listening, as a tool, reconnects people with nature, playing a vital role in artistic efforts to provoke thought, action and activism. As Duncombe (2016) argues, art is only truly valuable if it engages its audience and stimulates continuous reflection and, ideally, activism. It is essential for people to maintain an ongoing connection with the soundscapes around them, engaging with, questioning and participating in their urban-acoustic environment. The aim is to maintain a continuous engagement with any soundscape, through understanding, questioning and, above all, participating in our urban-acoustic positioning. This situation can initially be achieved by recognizing that the environment is facing problems stemming from human existence, and subsequently, by gradually addressing this issue. As Louro et al. (2021) argue, we are living in a *Sonic Anthropocene*—an era in which human activity increasingly alters natural and urban soundscapes, transforming them into markers of ecological crisis. Similarly, Warren et al. (2006) highlight how urbanization reshapes acoustic environments, often masking biological sounds and contributing to a significant loss of biodiversity. Engaging with these issues through active listening and participatory awareness becomes essential for restoring and preserving the ecological integrity of soundscapes.

3.2. Soundscapes and Environmental Art: Mobilizing Public Action through Listening

Environmental art can serve as a tool for mobilizing the public and promoting political action, encouraging individual and collective participation in the ecological agenda. Examples such as *River Listening* and *Biosphere Soundscapes* are interdisciplinary projects aim at inspiring communities worldwide to "listen to the environment and explore the value of sound as a measure of environmental health" (Barclay, 2018, p.179). Through the collaboration of artists and scientists, the goal is to encourage participants to explore the significance of sound and the environment (Vandsø, 2020; Gilmurray, 2021).

Sound artworks that incorporate environmental sounds often focus on ecology and the human impact on specific locations (Holmes, 2022, p.29). However, many soundscape creations explore other directions beyond the environment, addressing issues such as anti-racism or police violence, and are disseminated through various media, such as radio (Yoganathan, 2021). It cannot be guaranteed that the purpose of soundscapes is to promote environmental awareness or activism, as many do not carry explicit political messages or calls to action (Reich, 2018, p.16). Nevertheless, their impact lies within the act of listening itself, encouraging audiences to engage with a hidden "perspective" through non-anthropocentric lenses (Reich, 2018). Thus, a sound composition can serve as a form of "creative activism".

Listening is one of the fundamental elements of this sustainable way of being, which can be taught, for example, through soundscape compositions (Reich, 2018). A soundscape is a type of artwork that involves a complex array of sound phenomena, representing an *audiosphere*, the sonic moment of a specific place and time. Through electroacoustic processing, it can offer a deep dive into a different reality.

3.3. Case study: The soundscape of Pedion Areos

Pedion Areos, one of the largest parks in Athens, is a unique space of greenery and tranquility within the urban fabric. During the pandemic, the reduced human activity gave the opportunity to explore the sound character of the park. In this section, the study presents the soundscape of the Pedion Areos and the role that listening plays in our relationship with the urban environment and nature. The soundscape, that is, the collection of sounds present in a space, affects our experience of that space and provides valuable information about the state of the natural environment. This was achieved through soundwalks and endless strolls within the park.

The park is an oasis of greenery in the center of Athens, offering a breath of fresh air in the urban environment. However, it continues to be surrounded by the sounds of the city. Even if tranquility prevails inside, there will always be a sound that disrupts the peace of the space: machines, sirens, horns or even the continuous low sound (the urban *noise-floor*) that dominates the city center. Noise pollution, as referenced by Volcler (2013, p.152) in relation to Murray Schafer's observations from 1977, is a phenomenon where "increasingly larger sounds indiscriminately and imperialistically spread into every corner of human life". This sonic invasion distances people from the tranquility offered by the natural landscape, making the protection of the soundscape

necessary, especially in spaces like the Pedion Areos. However, despite the "brutality" of urban noise pollution, the park maintains its own soundscape, allowing space for both human and natural activities.

Within the park, events such as markets, exhibitions and concerts and even crowds often disrupt the quiet. These sounds vary depending on the time of day and the season. For example, in the summer, the park fills with visitors in the afternoons, while in the winter, visitors prefer the morning and midday hours. During the summer months, when the temperature keeps visitors at the beach, cicadas and birds take center stage in the park's soundscape. As Droumeva (2010) points out, this Biophony enhances the natural experience of listening.

Interestingly, younger children occasionally come across a turtle in the park, offering a rare moment of discovery. However, many may miss this opportunity entirely because, in today's world, dominated by visual stimuli (Jeziński & Lorek, 2020), it is often the sense of sight that dictates awareness. In this case, without seeing the turtle, children may not realize there is any life present, highlighting the diminished role of listening in a culture where vision has become the primary way of perceiving reality.

The observation of soundscapes is possible even in a neighborhood park, as long as we give it enough attention and are not disturbed by human activity. Besides organized events, individual actions like children's parties, fitness activities with music and cafes that operate late into the night can also disrupt the tranquility not only of the park but also of the surrounding streets. However, there are moments when more silence prevails, such as during religious holidays (e.g., Easter or the Assumption – 15th August), when the city empties, and human sounds drastically decrease. On weekdays, the evening hours have the most sonically peaceful, with runners wearing headphones becoming detached from the park's natural sound environment. They become detached, of course, and lose their perception of the soundscape which, is also kind of sad.

These observations lead to the initial conclusions that the attention to the environment is still insufficient, and that most "unnecessary" sounds come from people who disregard their acoustic surroundings. It can be argued that the need to improve this situation is essential, and this is made audible through soundwalks and the more targeted approach adopted for this research. After all, for someone involved in the study of sound, the exploration and study of the acoustic environment is a daily pursuit. However, it is important for this concern to be shared with others as well. The park, which holds the most natural form of the world, is nearby, and it is necessary to preserve its state as best as possible, while also absorbing what it has to offer us.

3.4. Listening for Urban Soundscape Preservation: Pedion Areos

Observing the soundscape through listening offers a unique opportunity to overcome the division between nature and culture, contributing to their reunification (Vandsø, 2020). The Pedion Areos is not just a space for social interaction and entertainment; it is also a point of reconnection with the natural environment within the city. Listening can help us to better understand the role of nature in the urban environment and strengthen our relationship with it. As Saher (2016) and Barclay (2018) emphasize, listening is a fundamental tool for human progress and understanding our environment. Through this process, it became clear how important direct contact with nature is and how much on-site listening can offer without the need for additional tools.

The most significant conclusion I drew from this process was the realization of the need to protect and enhance the soundscape of urban parks. It is positive that citizens utilize the Pedion Areos in various ways, but it is important to pay greater attention to the sound environment of the space and how it is affected by human activity. This research proposes implementing policies or actions that will limit the disturbance to the soundscape, particularly from intense human interventions such as the excessive use of music in communal areas.

Listening can contribute to improving our relationship with nature and allow us to experience the urban environment in a quieter, deeper and more meditative way. The Pedion Areos, as a social and natural space, offers this opportunity, and it is up to us to take advantage of it. There is no need for extraordinary measures to achieve this goal. A simple solution could be the addition of signs that encourage the maintenance of silence, as is already done with signs prompting visitors to "keep the space clean". This initiative could raise visitors awareness of the value of silence for the park's natural and sound environment. In addition to installing signs promoting silence, local parks could host community workshops on Sound Ecology, engaging residents in understanding the importance of their auditory environment.

However, whether such an effort will have long-lasting results depends on the attitude of the visitors. Collective actions, which usually create large crowds, often encourage an increase in vocal intensity and sound pollution.

In contrast, more individual initiatives, such as keeping voice intensity at low levels, could represent a good start for the protection of the soundscape. This individual responsibility, accompanied by broader awareness, could serve as a model of respect towards the environment and others. Let us commit to a quieter urban experience by consciously lowering our voices, turning down the volume of music in public spaces, and advocating for sound-conscious policies that protect our natural sound environments.

It is important for awareness of the significance of the sound environment to be more widespread and organized. The maintenance of silence and respect for the soundscape should be applied to all green spaces, not just the Pedion Areos. As previously mentioned, appreciation for others, the environment and nature is a vital element in this effort. The climate crisis affects not only the natural landscapes but also our relationship with them, making their protection more urgent than ever. Listening, as a key tool for human progress, is not just an aesthetic experience, but also an important factor in physical and mental well-being, enhancing our connection with the natural environment.

4. Conclusion

The text highlights the urgent need for an ecological turn of the human activities to ensure a sustainable future for all life on the planet. The limited ecological awareness of the global population, influenced by humanity's self-destructive tendencies, makes the process of environmental protection even more imperative. Ecological justice and a post-anthropocentric worldview are fundamental to reversing environmental damage. Furthermore, Acoustic Ecology, now more relevant than ever, reframes listening as an active, ethical response to the environmental crises we are living through.

Individual responsibility and citizen commitment are crucial for achieving real change, while engagement through sound can create that commitment and encourage our attention to our natural and sonic environment. Ongoing engagement with the sounds and acoustic locations of our urban environment is essential for developing a deeper sense of responsibility and care for the environment. Overall, listening and art emerge as key means of mobilization and awareness-raising for environmental protection and promoting an ecological spirit. Ways of acting with the sounds of nature, such as sound walks or active listening, can serve as means of resistance in the struggle for the salvation of the environment. As participants recognize what is happening and focus on the problem, they engage in activist action for the restoration of the environment and the reassessment of sound.

Through experiential and active listening to the natural environment, I developed a deeper appreciation for it. This personal experience confirmed the findings of the literature review, highlighting the beneficial impact of connecting with the park and listening to the natural soundscape, which enhanced my sense of calm and well-being. Therefore, sessions like these can provide a meaningful opportunity to connect with nature, offering a form of escape from daily routines. While there was no direct activist activity involved, sharing this experience with friends could encourage people to listen more actively to their surroundings, motivating them to seek out similar excursions to green spaces. People can react to sonic stimuli, and it is beneficial to accept the sound of the environment, especially that of nature, to move forward better.

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A Hypothesis on the Influence of Ground Vibrations and Geophonic Sounds on Human Brain Activity

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Abstract

This study explores how ground vibrations affect human brain activity by converting geophone data into auditory stimuli. Participants' physiological responses were monitored during exposure to natural and urban vibrations. Results suggest that natural low-frequency vibrations promote relaxation, while urban vibrations increase stress. The findings highlight the therapeutic potential of natural frequencies and the negative impact of urban noise, emphasizing sonification as a valuable research tool.

Keywords

Acoustic ecology, geophonic sounds, ground vibrations, sonification, human brain activity

1. The Therapeutic Power of Sound

1.1. Ancient Greece

Jill Gordon at *Hearing, Sound, and the Auditory in Ancient Greece*, presents the importance of sound in ancient Greek philosophy, medicine, and daily life. The collection of essays examines how sound was interpreted and understood by ancient thinkers such as Pythagoras, Aristotle, and Plato (Gordon, 2022, pp. 12-34). It portrays how ancient Greeks viewed sound both as a sensory experience, and as a natural phenomenon deeply connected to physical vibrations. Gordon in his study illustrates how vibrations were thought to influence both the body and the soul, and Huffman emphasised such influence on harmonic principles derived from the natural world (Huffman, 1993, pp. 52-60).

Furthermore, Aristotle highlighted the physiological effects of sound and vibrations, suggesting that sound, through its vibrations, had the ability to affect the human body by resonating with its various organs (ibid, pp. 63-72). This idea laid the foundations for the understanding of how natural vibrations, such as those found in the environment, may interact with the body's internal rhythms (Schafer, 1993, pp. 23-27), a very prominent concept in R. Murray Schafer's theoretical work regarding the properties of sound. The ancient Greeks believed that listening to harmonic sounds —those that resonated with natural vibrations— could promote health by synchronising with the body's internal vibrations, a very important notion in modern sound healing and vibrational medicine practices (Gerber, 2001, pp. 89-101).

1.2. Contemporary studies

The exploration of sound's impact on the human body, from ancient harmonic theories to modern vibrational medicine, underscores its profound influence on physiological and psychological states. Building on this

foundation, the phenomenon of Autonomous Sensory Meridian Response (ASMR) offers a contemporary lens to examine how specific auditory stimuli evoke different sensations, as much as therapeutic effects through intricate neural and sensory mechanisms. ASMR has been shown to positively affect mood, lower heart rate, and promote relaxation. A study by Poerio et al. (2018) demonstrates that individuals experiencing ASMR showed significant reductions in heart rate and increased skin conductance, indicating relaxation and heightened attention. Additionally, EEG recordings from ASMR-sensitive participants showed decreased alpha and theta wave power and increased beta wave power, reflecting enhanced focus and a relaxed alert state (Smith et al., 2017).

Research on the effect of vibrations on human health such as *Noise and Health: Effects of Low-Frequency Noise and Vibrations*, highlights that low-frequency sound can have both positive and negative effects on health (American Institute of Physics, 1996). Prolonged exposure to non-natural low-frequency noise in environmental and occupational settings has been shown to increase stress, disrupt sleep, and lead to long-term health problems. In contrast, natural low-frequency vibrations —such as those found in nature or caves— can foster a sense of calm and restoration. For example, the acoustic properties of caves, combined with the deep, low-frequency sounds of nature, provide powerful environments for meditative practices and modern sound therapy, underlining the importance of natural low frequency vibrations in fostering mental and physical health (Gaynor, 2002, pp. 32–47).

According to R. M. Schafer (1994), the natural soundscape plays a fundamental role in shaping peoples' cognitive and emotional experiences, providing relief from the overstimulation caused by urban and industrial environments. Natural low-frequency sounds, such as ocean waves, thunderstorms, wind rustling through trees, waterfalls, and cave ambiances, have been widely recognized in research for their positive impact on human health and well-being. The rhythmic crashing of ocean waves and the deep rumble of distant thunder promote relaxation, reduce stress, and aid sleep (Orban & Papenburg, 2020). Similarly, the sound of wind and the continuous roar of waterfalls create a calming atmosphere that enhances mental clarity and masks disruptive noise (Buxton et al., 2014). Unique acoustic environments like caves amplify low-frequency sounds, fostering meditative and restorative states (Karjalainen et al., 2021). These natural vibrations, often associated with bio-acoustic and environmental studies, counteract the harmful effects of anthropogenic low-frequency noise.

This concept is reflected in contemporary practices like acoustic ecology and sound healing, where exposure to natural soundscapes is used to reduce stress and improve mental and physical health (Krause, 2012, pp. 82–88). Krause emphasizes that “natural soundscapes are not merely background noise; they are essential to our emotional and physical well-being.” He furthermore illustrates how exposure to natural soundscapes, like birdsong or the sound of running water, can reduce stress, enhance mental clarity, and restore balance, contrasting the often-harmful effects of human made, urban soundscapes. This evolving understanding of soundscapes underscores their dual role as ecological assets and therapeutic tools.

Moreover, studies on the human perception of environmental sounds highlight humans' innate ability to perceive and respond to natural soundscapes. The concept of resonance, where two vibrational systems interact and exchange energy, is now understood to influence how humans respond to sound even at the cellular level (Beaulieu, 2010, pp. 65–69). These findings emphasise the fundamental role of natural vibrations in maintaining physical and emotional health, offering a compelling argument for preserving and integrating natural soundscapes into modern life.

2. Geophony, and the Human Response to Low Frequency Environmental Vibrations

Auditory environments encompass both human-made sounds and those caused by natural phenomena, such as geophonic sounds. Acoustic ecology, the study of the relationships between living organisms and their auditory environments, has often served as a framework to explore how environmental sounds affect humans and their well-being. Research in this field has revealed that ground vibrations and other geophonic sounds can influence human brain activity, auditory perception, and physiological states (Schafer, 1994). The perception and neural responses to these sounds depend on their frequency, intensity, and duration (Zwicker & Fastl, 2013). Additionally, the sonification of geophysical data —i.e., the transformation of seismic activity data into audible sound— has been shown to enhance the understanding of these natural processes and positively influence cognition and emotions (Walker & Myrick, 2006). Furthermore, studies suggest these natural low frequencies can deepen meditative states, promote relaxation, and enhance cognitive clarity (Smith et al., 2019; Bartel & Mosabbir, 2021). Theta waves, often observed during light meditation or drowsiness, are enhanced by exposure

to high-intensity geophonic sounds, further deepening meditative states (Brown, 2018). Controlled exposure to natural low-frequency sounds has been shown to reduce stress and improve relaxation, as demonstrated by Ishizuka et al. (2016) and Horowitz (2015).

Conversely, it appears that while natural geophonic sounds often seem to offer calming and relaxing effects to listeners, artificial low-frequency vibrations can lead to discomfort. Sounds below 20 Hz, such as those produced in industrial settings, have been found to cause unease, disrupt sleep, and increase stress (Leventhall, 2004). Prolonged exposure to such noise pollution can impair concentration and cognitive performance, particularly to individuals living near industrial areas. This highlights the importance of mitigating the negative impacts of anthropogenic low-frequency noise while exploring sonification techniques to study ground vibrations and their physiological effects.

Could it be that natural sounds activate the parasympathetic nervous system, the part of the body responsible for rest and recovery, and synchronize brain activity with delta and theta waves, which are linked to sleep, relaxation, and inner calmness (Altenmüller et al., 2004)? Might infrasound (below 20 Hz), often produced by geophonic sources, be detected by mechanoreceptors in the skin and muscles, eliciting physical sensations such as chest pressure, skin vibrations, and alterations in heart rate and breathing patterns (Fox & Schürmann, 2002; Schürmann et al., 2000)?

3. Experiment Design and Methodology

To enhance the interpretability of complex and abstract data, ground vibration recordings from the SM-24 geophone were sonified using Fast Fourier Transform (FFT). This process transformed the data into auditory soundscapes, offering a tangible representation of ground vibrations. The sonification was then presented to listeners, allowing them to directly experience and interpret the vibrational data through sound. This approach not only facilitated analytical insights but also served as an artistic medium for engaging participants with the findings.

Building on the literature review, the practical component of this research investigates the impact of auditory and vibrational environments—both natural and industrial—on participants' emotional and physiological states. A mixed-methods approach, combining qualitative and quantitative analysis, was employed. Physiological data, including Electroencephalography (EEG), Galvanic Skin Response (GSR), and Heart Rate (HR), were collected alongside qualitative feedback from participant interviews. To assess the effect of low-frequency vibrations on human subjects, the sonified ground vibrations were presented as auditory stimuli, providing a multi-sensory perspective on the relationship between vibrational environments and human perception.

3.1. Data Collection Framework

The experiment employed a comprehensive framework for data collection, integrating three main components: vibrational and geophonic data capture, auditory stimuli, and physiological measurements.

Vibrational and geophonic data were recorded using an SM-24 geophone connected to an Arduino microcontroller, allowing for precise detection and conversion of low-frequency ground vibrations into electrical signals. The study focused on two primary frequency ranges: 11 Hz, commonly observed in natural landscapes, and 30 Hz, recorded in urban environments. Vibrational data were collected from both natural settings, such as forests, wind, and seismic activity, and urban environments, including subway systems and road noise.

To examine participants' responses, curated auditory stimuli were developed from the recorded vibrational and geophonic data. These stimuli consisted of natural soundscapes, such as forest sounds, wind, and seismic vibrations, as well as urban noise, including synthetic representations of subway activity, road noise, and industrial vibrations. The auditory stimuli were synchronized with brainwave frequencies associated with specific mental states, particularly theta waves (linked to relaxation) and alpha waves (associated with calmness), to explore their potential cognitive and physiological effects.

The study involved approximately 15 participants, who were exposed to these stimuli in a controlled setting. Physiological responses were assessed through Galvanic Skin Response (GSR) and Heart Rate (HR) measurements. Emotional arousal and stress levels were monitored using Grove GSR sensors, which recorded changes in skin conductance corresponding to autonomic nervous system activity. These fluctuations provided reliable indicators of stress or relaxation. Additionally, heart rate data was collected to evaluate physiological

arousal during exposure to both auditory and vibrational stimuli, offering further insight into the body's reaction to different environmental soundscapes.

The methodology followed these key steps:

1. Listening Sessions: Participants attended listening sessions where they were exposed to curated soundscapes, including both natural and urban environments.
2. Physiological Monitoring: During the sessions, EEG, GSR, and HR data were continuously recorded to track real-time physiological responses.
3. Post-Exposure Feedback: Participants provided feedback after the sessions, describing their subjective experiences and emotional states.
4. A particularly noteworthy finding was that after the 30 Hz frequency was removed from the room and speakers, the majority of participants reported feeling approximately 80% relieved.

3.2. Hypothesis

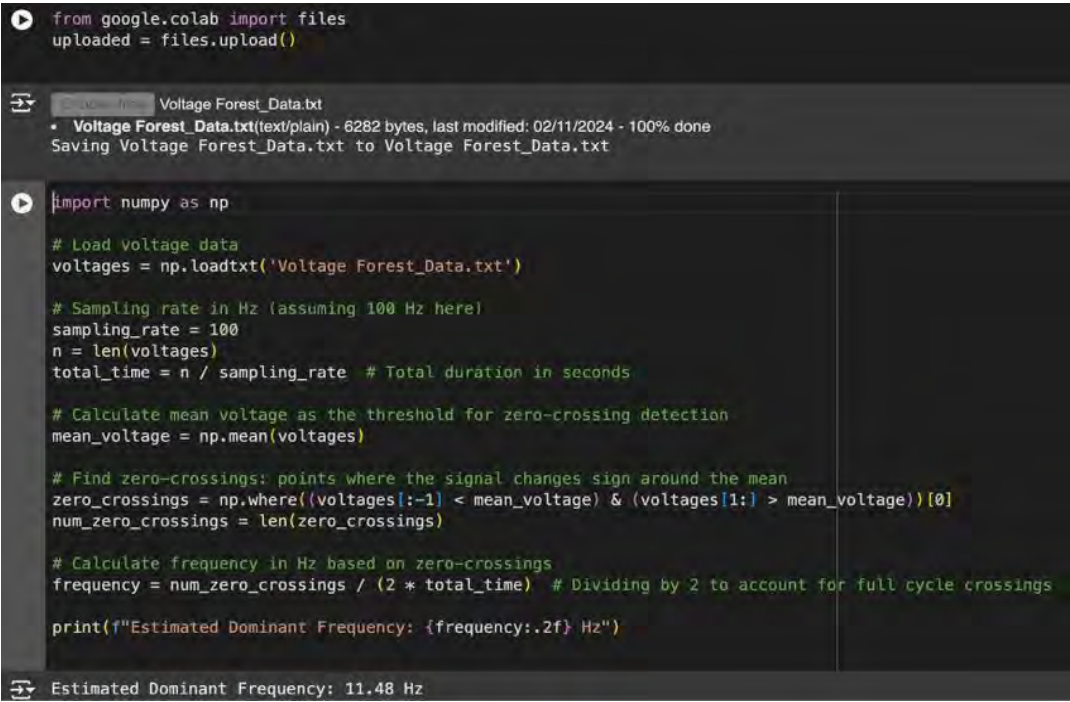
The central hypothesis of this research posited that specific auditory stimuli and low-frequency vibrations would elicit distinct mental and physiological responses:

- Natural soundscapes and low-frequency vibrations (10-20 Hz, particularly 11 Hz) were expected to promote relaxation and meditative states, corresponding to increased theta and alpha wave activity.
- Urban soundscapes and slightly higher-frequency vibrations (30-50 Hz) were anticipated to induce heightened cognitive engagement or stress responses, associated with increased beta wave activation.

3.3. Data Analysis

The collected data was analyzed to identify correlations between:

- Auditory and vibrational stimuli and changes in EEG frequency bands.
- GSR and HR measurements as indicators of stress or relaxation.
- Subjective feedback and physiological responses, ensuring a holistic understanding of participants' experiences.



```
from google.colab import files
uploaded = files.upload()

Voltage Forest_Data.txt
• Voltage Forest_Data.txt(text/plain) - 6282 bytes, last modified: 02/11/2024 - 100% done
Saving Voltage Forest_Data.txt to Voltage Forest_Data.txt

import numpy as np

# Load voltage data
voltages = np.loadtxt('Voltage Forest_Data.txt')

# Sampling rate in Hz (assuming 100 Hz here)
sampling_rate = 100
n = len(voltages)
total_time = n / sampling_rate # Total duration in seconds

# Calculate mean voltage as the threshold for zero-crossing detection
mean_voltage = np.mean(voltages)

# Find zero-crossings: points where the signal changes sign around the mean
zero_crossings = np.where((voltages[:-1] < mean_voltage) & (voltages[1:] > mean_voltage))[0]
num_zero_crossings = len(zero_crossings)

# Calculate frequency in Hz based on zero-crossings
frequency = num_zero_crossings / (2 * total_time) # Dividing by 2 to account for full cycle crossings

print(f"Estimated Dominant Frequency: {frequency:.2f} Hz")

Estimated Dominant Frequency: 11.48 Hz
```

Figure 1. Program in Python for converting analog geophone data to electrical signals

4. Results

Exposure to natural geophonic vibrations at 11 Hz had a pronounced impact on participants' mental states. EEG data showed a significant increase in alpha brainwave activity, associated with calmness and wakeful relaxation, as well as a slight rise in theta wave activity, linked to deep relaxation and introspection. These findings suggest

that 11 Hz vibrations foster a relaxed yet alert state of mind, consistent with research indicating that alpha waves (8–14 Hz) synchronize with the brain's natural rhythms. Additionally, low beta wave activity (13–15 Hz), associated with mental clarity and focus, was observed, pointing to a harmonious balance between relaxation and cognitive engagement.

In contrast, exposure to medium-frequency vibrations at 31 Hz, derived from industrial environments such as subway noise, road activity, and bridge vibrations, produced markedly different effects. Participants reported heightened anxiety and stress, corroborated by physiological measurements. EEG data revealed a notable increase in beta wave activity, which is linked to heightened alertness and stress, while Galvanic Skin Response (GSR) readings spiked, indicating strong activation of the sympathetic nervous system and elevated arousal levels.

Additionally, the GSR measurements showed a pronounced peak, with sensor levels reaching 500 μ S (microsiemens), a clear indicator of sympathetic nervous system activation. This spike highlighted the heightened arousal state caused by exposure to the urban vibration frequency, aligning with participants' reports of increased anxiety and stress. Upon cessation of the sound exposure, all participants reported immediate relief and a sense of calmness. Physiological data corroborated these self-reports: beta and alpha wave levels returned to baseline, and GSR measurements dropped sharply from the 500 μ S peak. This rapid return to baseline levels reflected a decrease in arousal and stress once the vibrational stimulus was removed.

These results underscore the contrasting influences of natural and urban vibrational environments. Natural geophonic frequencies like 11 Hz demonstrated a restorative effect, promoting relaxation and focus, whereas urban noise at 31 Hz disrupted mental states, inducing stress and discomfort. These findings highlight the therapeutic potential of natural vibrations and the need to mitigate the negative effects of urban noise.

5. Conclusions

The findings of this research demonstrate that low frequencies, particularly within the range of 10–15 Hz, are strongly associated with the activation of alpha brainwaves, which are linked to states of calmness, relaxation, and wakeful rest. This supports the hypothesis that these specific frequencies exert a natural and beneficial influence on human psychophysiology.

The 11–15 Hz frequencies were predominantly identified in natural environments, such as ground vibrations, wind, and forest sounds. These results suggest that these frequencies are intrinsically connected to the Earth's natural processes, making them inherently familiar and "proximal" to humans. Their alignment with alpha wave activity underscores the idea that exposure to such frequencies resonates deeply with the human nervous system, fostering a sense of balance and tranquility.

This conclusion highlights the significance of the Earth's vibrational patterns in shaping human emotional and physiological states, suggesting that such frequencies may play a foundational role in our perception of what feels "natural" and restorative.

These results underline the crucial role of natural soundscapes in promoting mental and emotional well-being. As urbanization accelerates and natural environments face degradation, the restorative qualities of natural sounds become increasingly essential. Conversely, the prevalence of malicious urban noise highlights the urgent need for strategies to mitigate its impact on human health. This study reinforces the importance of preserving natural environments and integrating their auditory elements into urban design and public health initiatives to counteract the detrimental effects of urban soundscapes.

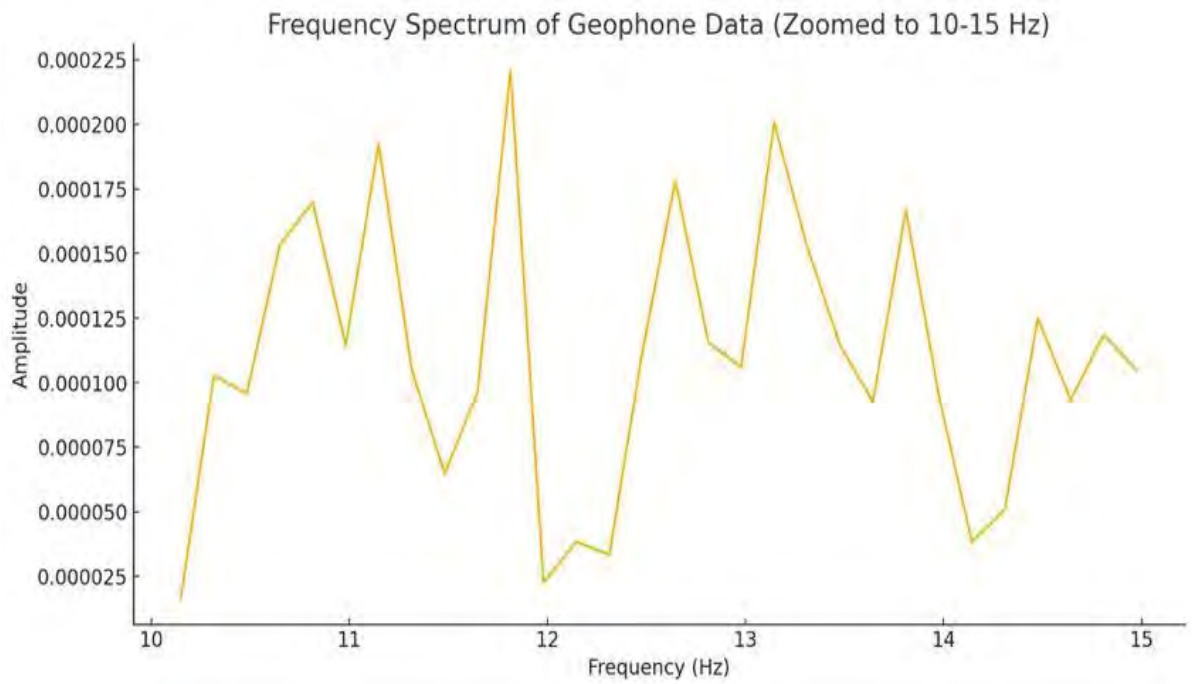


Figure 2. Frequency Spectrum of Geophone Data. Data Sonification

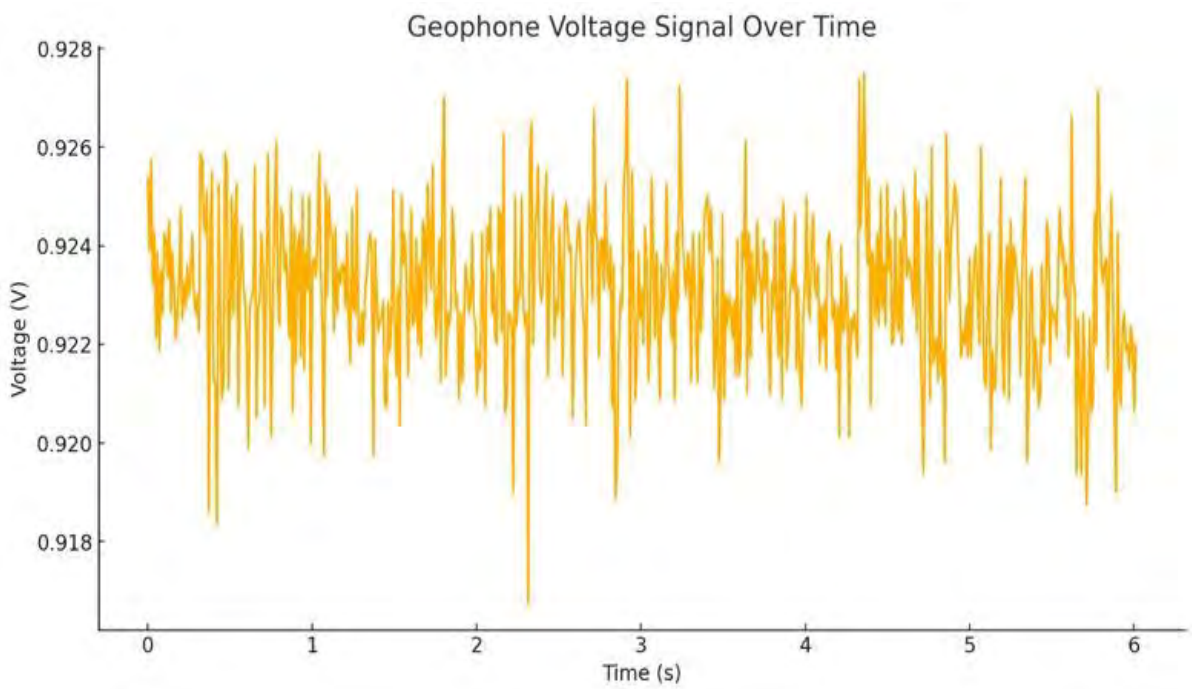


Figure 3. Geophone Voltage Signal over time. Data Sonification

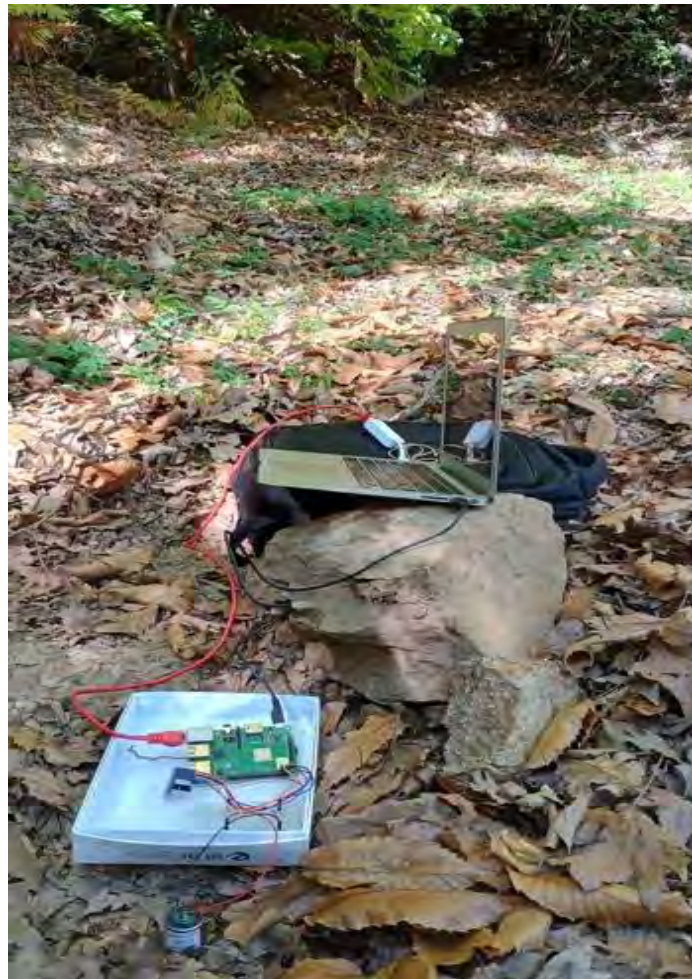


Figure 4. Measurements in the forest



Figure 5. Measurements in urban environments

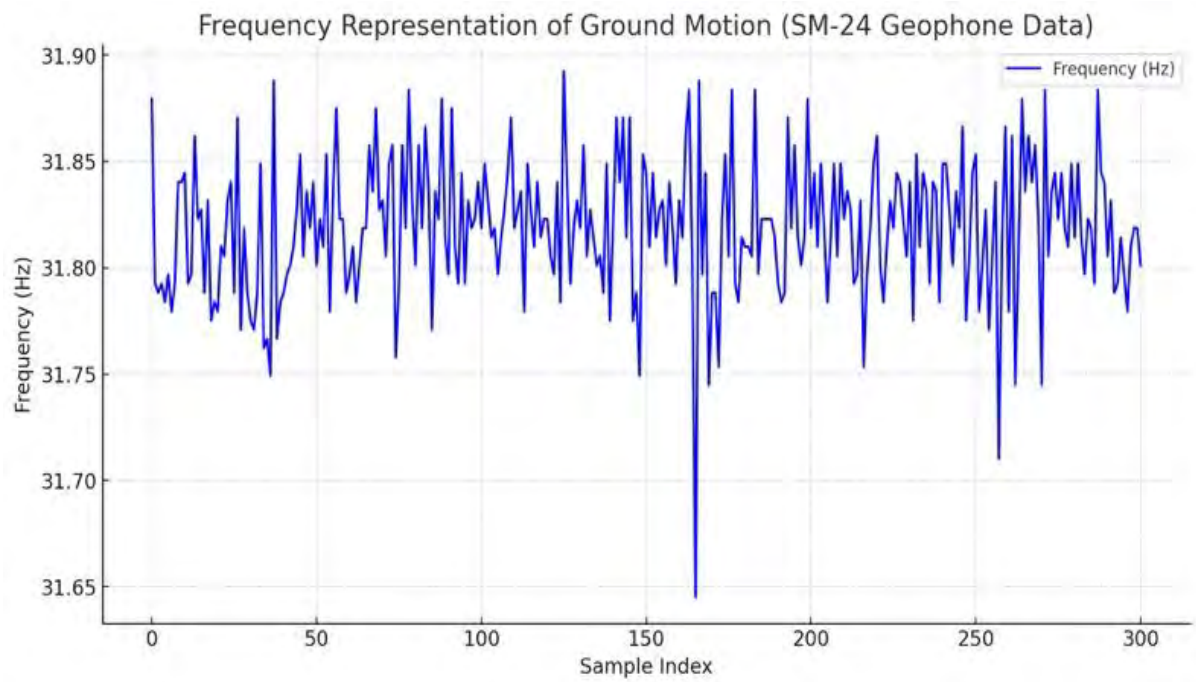


Figure 6. Frequency Representation of Ground Motion ($\cong 31$ Hz)

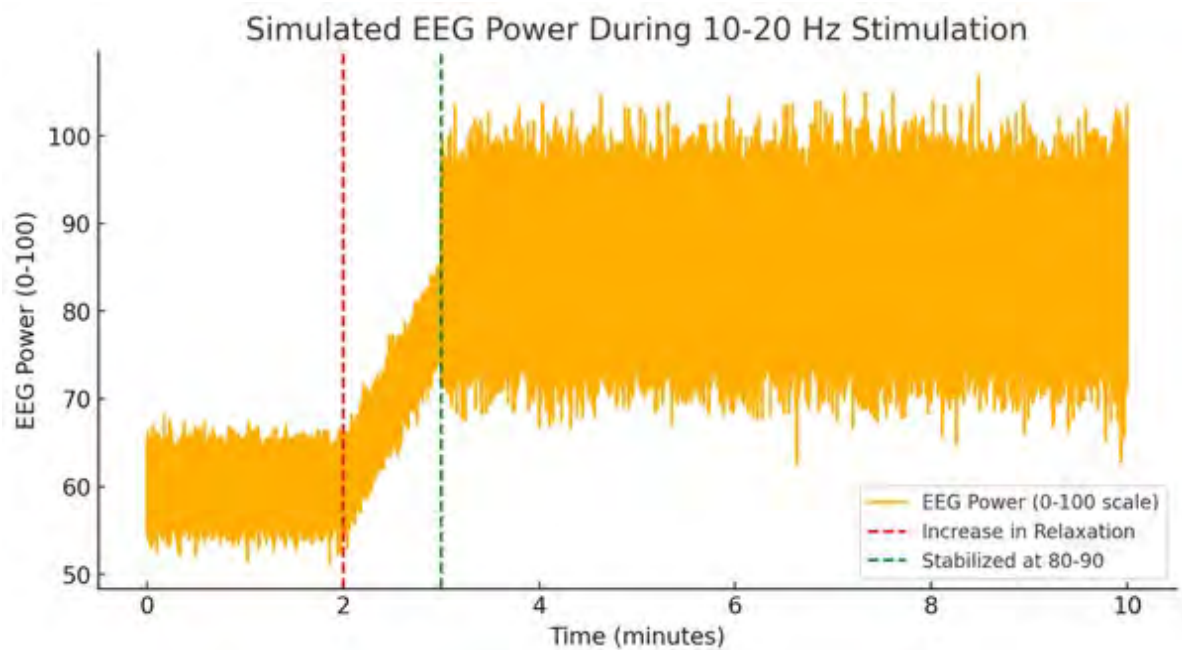


Figure 7. Meditation Level Measured with NeuroSky Headset

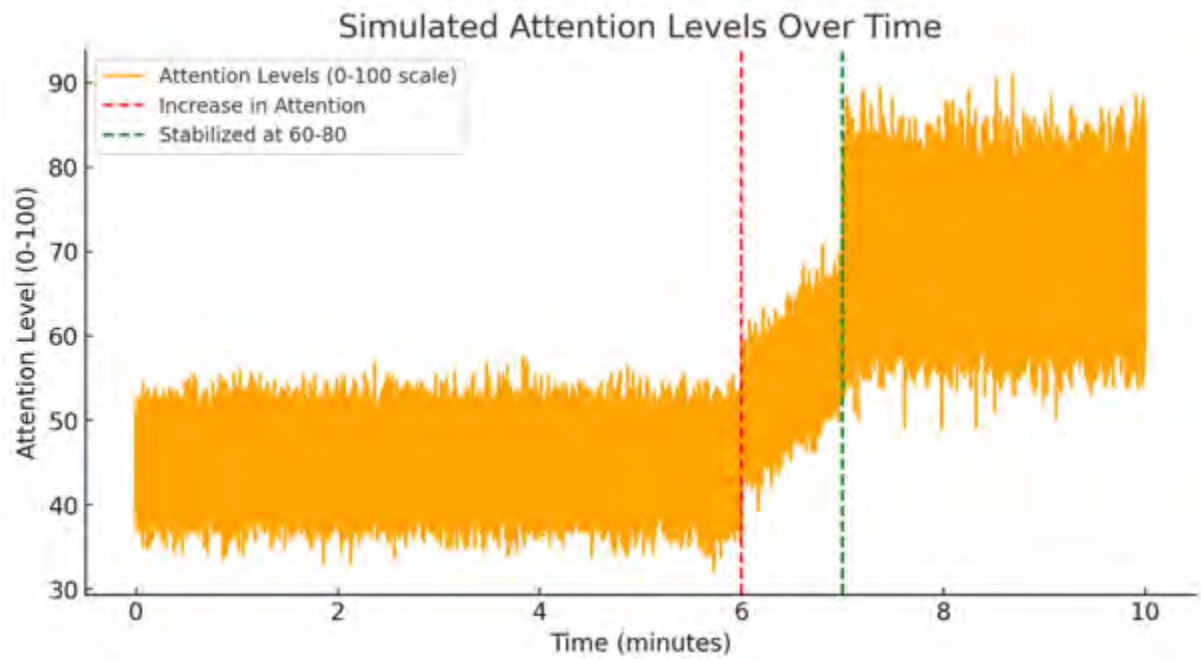


Figure 8. Attention level Measured with NeuroSky Headset

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Ανάδειξη της φυσικής και πολιτισμικής κληρονομιάς μέσω ηχοτοπίων- Περίπτωση μελέτης: η θαλάσσια προστατευόμενη περιοχή της Γυάρου

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Περίληψη

Η προστασία της φυσικής και πολιτιστικής κληρονομιάς αποτελεί πρόκληση για τη διατήρηση της μνήμης. Η Γυάρος, τόπος φυλάκισης και εξορίας καθώς και Εθνική Θαλάσσια Προστατευόμενη Περιοχή, αποτελεί την περιοχή μελέτης. Η περιβαλλοντική ερμηνεία διευκολύνει τον επισκέπτη να ενημερωθεί και να λάβει πληροφορίες για μια περιοχή, επιτρέποντάς του να κατανοήσει τη φυσική και πολιτιστική της σημασία είτε με φυσική παρουσία είτε εικονικά, μέσω ψηφιακών μέσων. Η παρούσα έρευνα αποτελεί μέρος του Προγράμματος "CLLD-LEADER" και εστιάζει στη δημιουργία υλικού ευαισθητοποίησης για γενικές και ειδικές ομάδες. Το υλικό που δημιουργήθηκε περιλαμβάνει: ηχητικά μονοπάτια, ηχοτοπία, οπτικοακουστικό υλικό για τις διαδρομές, 32 διαφορετικές αφηγήσεις ως ηχητικές περιηγήσεις, βίντεο με ηχοτοπία σε διαφορετικές εποχές. Επιπλέον, δημιουργήθηκαν φωτογραφική και ηχητική βιβλιοθήκη. Για την καταγραφή του οπτικοακουστικού υλικού και των ηχοτοπίων, χρησιμοποιήθηκε εξοπλισμός που αποτύπωσε με αξιοπιστία και ρεαλισμό το ανάγλυφο της Γυάρου, τα οικοσυστήματα, τη βιοποικιλότητα και τα ηχοτοπία της.

Η εικονική επίσκεψη σε έναν τόπο και η δημιουργία μιας (ηχητικής) διαδρομής με δυνατότητα επιλογής σημείων ενδιαφέροντος, ανάλογα με τις προτιμήσεις του επισκέπτη, δημιουργεί δυναμική αλληλεπίδραση με τον τόπο καθώς και προσωπική εμπειρία. Παράλληλα, η καταγραφή και αποτύπωση ενός ολόκληρου νησιού με οπτικοακουστικό υλικό και ηχοτοπία αποτελεί μια ολιστική προσέγγιση στο πλαίσιο της περιβαλλοντικής ερμηνείας.

Λέξεις κλειδιά

Γυάρος, Προστατευόμενες Περιοχές, Ηχοτοπία, Αφηγήσεις, Περιβαλλοντική Ερμηνεία

1. Εισαγωγή

Σε περιοχές όπου είτε η ιστορική μνήμη είτε τα στοιχεία βιοποικιλότητας συνιστούν την κύρια ταυτότητά τους, η προβολή της περιοχής θα πρέπει να περιλαμβάνει ιστορικές αναφορές, αξιόπιστες πληροφορίες και δεδομένα που να αναδεικνύουν τις διαφορετικές πτυχές που συνέβαλαν ιστορικά στη διαμόρφωση αυτής της ταυτότητας ή αντίστοιχα να περιλαμβάνει πληροφορίες για το φυσικό περιβάλλον.

Η Γυάρος, η περίπτωση μελέτης της έρευνας, υπήρξε τόπος φυλάκισης και εξορίας και έχει σημαδέψει την ελληνική ιστορία. Αυτό το άγονο νησί φιλοξένησε για αρκετά χρόνια πολιτικούς εξόριστους, οι οποίοι φυλακίστηκαν, απομονώθηκαν και τιμωρήθηκαν για τις πεποιθήσεις τους. Το κεντρικό κτήριο της φυλακής, μαζί με όλα τα ερείπια και τα διάσπαρτα κτήρια στους όρμους και τις πλαγιές, αποτελούν «μάρτυρα» της ιστορίας της και των σκληρών συνθηκών διαβίωσης εκεί.

Παράλληλα, λόγω της σημαντικής περιβαλλοντικής αξίας της, η Γυάρος χαρακτηρίστηκε ως Θαλάσσια Προστατευόμενη Περιοχή το 2019. Η χερσαία και η θαλάσσια βιοποικιλότητα και τα οικοσυστήματά της φιλοξενούν πολλά απειλούμενα και σπάνια είδη χλωρίδας και πανίδας (Παπαδάς, 2018). Οι Προστατευόμενες

Περιοχές (ΠΠ) είναι αναγνωρισμένες διεθνώς ως περιοχές ιδιαίτερης σημασίας για τη διατήρηση της φυσικής και πολιτισμικής μας κληρονομιάς και η διαχείριση και προστασία τους αποτελεί προτεραιότητα και πρόκληση για την εναλλακτική ανάπτυξη. Στην Ελλάδα οι ΠΠ καλύπτουν περίπου το 30% της χερσαίας και θαλάσσιας έκτασης της.

Η περιβαλλοντική ερμηνεία προβάλλει πληροφορίες και δεδομένα διευκολύνοντάς την κατανόηση της πολιτισμικής και φυσικής σημασίας της είτε στο πλαίσιο μιας προσωπικής επίσκεψης είτε εικονικά. Σε πολλές περιπτώσεις, η επίσκεψη στην περιοχή είναι δύσκολη ή μπορεί ακόμη και να είναι αδύνατη. Η οπτικοακουστική αποτύπωση μιας περιοχής χωροχρονικά, διευκολύνει την περιβαλλοντική ερμηνεία και παρέχει την ευκαιρία για μια εικονική επίσκεψη σε όλους.

Στην παρούσα έρευνα, στο πλαίσιο του Προγράμματος CLLD-LEADER με τίτλο: «Ολοκληρωμένο σύστημα περιβαλλοντικής ενημέρωσης και ευαισθητοποίησης και δράσεις αναβάθμισης για την προστατευόμενη περιοχή της νήσου Γυάρου» του WWF Ελλάς, σε συνεργασία με την ΟΙΚΟΜ και συγκεκριμένα στο Υποέργο: «Εικονική ξενάγηση – Δημιουργία εμπειρίας in situ για άτομα με αναπηρίες», αναπτύχθηκε μια ολοκληρωμένη αφήγηση που περιλαμβάνει στοιχεία και πληροφορίες για την πολιτιστική και φυσική κληρονομιά της Γυάρου. Το κεντρικό σημείο αναφοράς για τη δημιουργία του υλικού ήταν τα ηχοτοπία όλης της γεωγραφικής έκτασης του νησιού καθώς και οπτικό υλικό (βίντεο και φωτογραφίες). Ειδικότερα, για την ακριβή αποτύπωση, δημιουργήθηκε μια διαδρομή 32 διαφορετικών σημείων, που καλύπτει τόσο το χερσαίο τμήμα όσο και τμήματα της θαλάσσιας περιοχής. Αυτά τα σημεία περιλαμβάνουν τοπόσημα που συνδέονται με την ιστορία της Γυάρου ενώ παράλληλα καταγράφηκε και αποτυπώθηκε η βιοποικιλότητα και τα οικοσυστήματά της. Το υλικό σχεδιάστηκε και προσαρμόστηκε κατάλληλα και για ειδικές ομάδες περιλαμβάνοντας: ηχοτοπία, φωτογραφίες με απεικόνιση 360 μοιρών, 32 διαφορετικές αφηγήσεις ως ηχητικές περιηγήσεις, βίντεο με υπότιτλους, βίντεο με ηχοτοπία, ηχοτοπία αυτόνομα ή ως ηχητικά υπόβαθρα σε διαφορετικές εποχές (Εικόνα 1). Επιπλέον, δημιουργήθηκε μια φωτογραφική βιβλιοθήκη και μια ηχητική βιβλιοθήκη. Το υλικό φιλοξενείται στον ιστότοπο "Gyaros-Story" (WWF Ελλάς, 2024) και είναι διαθέσιμο και σε εφαρμογή, στο πλαίσιο επιτόπιας επίσκεψης, για κινητά, σε τρεις γλώσσες (ελληνικά, αγγλικά, γαλλικά). Για τη συγκέντρωση τόσο του οπτικού όσο και του ηχητικού υλικού, χρησιμοποιήθηκε ειδικός εξοπλισμός υψηλής πιστότητας για αποτύπωση των δεδομένων με αξιοπιστία και ρεαλιστικότητα.

Ο συνδυασμός ήχου και εικόνας δίνει μια ρεαλιστική διάσταση στο εγχείρημα, ενώ ο ρόλος των αφηγήσεων παρέχει στοιχεία ξενάγησης και μεταφέρει πληροφορίες γενικής και ειδικής φύσης. Η εικονική επίσκεψη και η δημιουργία μιας (ηχητικής) διαδρομής με τη δυνατότητα επιλογής σημείων ενδιαφέροντος, ανάλογα με τις προτιμήσεις του επισκέπτη, δημιουργεί αλληλεπίδραση καθώς και μια προσωπική, καθηλωτική εμπειρία. Σκοπός της έρευνας ήταν η ρεαλιστική αποτύπωση και ανάδειξη μιας περιοχής με σημαντική πολιτισμική και φυσική ταυτότητα, με σημείο αναφοράς το σεβασμό στην ιστορία και τη συλλογική μνήμη. Η έρευνα εστίασε στην προσβασιμότητα του υλικού σε όλους, γενικές και ειδικές ομάδες.



Εικόνα 1. Στιγμιότυπο του Σημείου 3 από την ιστοσελίδα, ενότητα Εικονικά

1.1. Ψηφιακή αφήγηση

Η ψηφιακή αφήγηση είναι ένα πολυμεσικό είδος περιβαλλοντικής ερμηνείας, συγκεκριμένης διάρκειας, το οποίο επιτρέπει με τη χρήση νέων τεχνολογιών να κοινοποιηθεί ψηφιακά μια ιστορία (Robin, 2008). Τα ψηφιακά αφηγήματα περιλαμβάνουν κείμενα, εικόνες, βίντεο, μουσική και οπτικά εφέ. Ο όρος ψηφιακή αφήγηση ή ψηφιακή ιστορία αποτελεί μετάφραση του αγγλικού όρου *digital storytelling*. Επίσης, για τις ψηφιακές αφηγήσεις χρησιμοποιείται και ο όρος *narratives*.

Η χρήση της ψηφιακής αφήγησης ως μέσο για την περιβαλλοντική ερμηνεία συμπεριλαμβάνει τις ακόλουθες διαστάσεις: α. κοινωνική, β. συναισθηματική, γ. γνωστική. Ειδικότερα, η αλληλεπίδραση ατόμου και αφηγήματος εστιάζει στην πρόσληψη πληροφορίας, γνώσης, αντίληψης. Σε ό,τι αφορά στη συναισθηματική διάσταση οι ψηφιακές αφηγήσεις ενεργοποιούν τα συναισθήματα, μεταφέρουν αξιόπιστες πληροφορίες ενδυναμώνοντας παράλληλα την ενσυναίσθηση. Η γνώση για κάποιο τόπο και για την ταυτότητά του δημιουργεί «άτυπες» μνήμες και συναισθηματική δέσμευση.

Η ερμηνεία περιβάλλοντος, για ένα τόπο με ισχυρή ιστορική μνήμη και περιβαλλοντική ταυτότητα, η ερμηνεία περιβάλλοντος με τη χρήση οπτικοακουστικών μέσων και αφηγημάτων, επαναπροσδιορίζει το χώρο μέσα από τη σημερινή μορφή του. Για την πραγματοποίησή της χρησιμοποιούνται αξιόπιστες ιστορικές πηγές, τεκμήρια, νέες τεχνολογίες, αφηγήματα ώστε να επιτευχθεί η αποτύπωση της περιοχής χωροχρονικά, στην παρούσα περίοδο αλλά ενεργοποιώντας παράλληλα τη φαντασία ώστε να προσληφθούν ήχοι και εικόνες του παρελθόντος (Hogg, 2015, pp. 281-302). Το χωρικό κενό, η διαφορετική δηλαδή μορφή του χώρου μέσα στο χρόνο, έχει αφηγηματική ταυτότητα και δύναμη και μεταφέρει ιστορίες, εικόνες, ηχοτοπία του παρελθόντος επαναφέροντας βιώματα και μνήμες (Mariani & Barron, 2014, pp. 2-6).

Τα αφηγήματα στην παρούσα έρευνα ακολουθούν διαδρομές που καλύπτουν όλη τη γεωγραφική έκταση της Γυάρου, με δυνατότητα 31 διαφορετικών στάσεων. Είναι μικρής χρονικής διάρκειας, εστιάζουν σε τοπόσημα και προσδίδουν γνώση για την ταυτότητα του νησιού στο παρελθόν. Εικονικά δε, απεικονίζουν, μέσω της περιγραφής και του οπτικοακουστικού υλικού την ιστορία του νησιού, τη βιοποικιλότητα, το τοπίο, τις δραστηριότητες των κατοίκων στο παρελθόν πριν η Γυάρος αποτελέσει τόπο φυλακή και εξορίας. Τα αφηγήματα στο "Gyaros-Story" αποτελούν είτε αυτόνομες ενότητες είτε μπορεί να θεωρηθούν ως ενιαία ενότητα στο σύνολό της. Η τρίγλωση καταχώρηση των αφηγημάτων στην ιστοσελίδα δίνει τη δυνατότητα ξενάγησης σε διαφορετικές ομάδες. Τα αφηγήματα, στην παρούσα έρευνα, μπορούν να συνδυαστούν και με οπτική ξενάγηση μέσω του φωτογραφικού υλικού ανά στάση καθώς και μέσω ηχητικών αρχείων (ηχοτοπία) και βίντεο, ενεργοποιώντας συναισθήματα και εμπειρίες εικονικής ξενάγησης. Το υλικό είναι προσβάσιμο για γενικές και ειδικές ομάδες, έχει ευελιξία στην επιλογή των εργαλείων που έχουν δημιουργηθεί στο πλαίσιο της ερμηνείας περιβάλλοντος και καλύπτει διαφορετικές ομάδες ΑΜΕΑ με αισθητηριακά προβλήματα, έχοντας ακολουθήσει το υφιστάμενο θεσμικό πλαίσιο (Μινώτου κ.ά., 2008).

Παρά το γεγονός ότι η Γυάρος στις μέρες μας αποτελεί ένα «σιωπηλό» τόπο όπως αποτυπώθηκε από τις καταγραφές των ηχοτοπιών της, κατορθώνει να μεταφέρει ηχηρά τις μνήμες και ο «κενός» χώρος ζωντανεύει (Casey, 1997, pp. 334-337). Ο συνδυασμός της αντικειμενικής πληροφορίας με την υποκειμενική ερμηνείας της (δια)συνδέει το παρελθόν με το παρόν και τα ηχοτοπία με εμπειρίες (Voegelin, 2010, pp.163-166).

2. Μεθοδολογία

2.1. Βιβλιογραφική έρευνα και ερωτηματολόγια

Για τη συγκέντρωση υλικού, το οποίο αποτέλεσε το σημείο αναφοράς για τη δημιουργία αφηγημάτων στο "Gyaros-Story" πραγματοποιήθηκε βιβλιογραφική έρευνα ώστε να συγκεντρωθούν στοιχεία, δεδομένα και τεκμήρια. Το υλικό που συγκεντρώθηκε κατηγοριοποιήθηκε σε δύο θεματικές σχετικά με την πολιτισμική και με τη φυσική ταυτότητα της περιοχής. Λόγω της ιδιαίτερης ιστορικότητας του τόπου, δόθηκε ιδιαίτερη έμφαση στην αξιοπιστία της πληροφορίας και των τεκμηρίων, καθώς και στην υιοθέτηση της προσέγγισης περιβαλλοντικής ηθικής και ηθικών θεωριών σε σχέση με το περιβάλλον (Γεωργόπουλος, 2002). Παράλληλα, συντάχθηκε ερωτηματολόγιο ανοικτού τύπου για ποιοτική έρευνα, με συμμετέχοντες από διαφορετικές ομάδες εμπλεκόμενων, που κάλυπταν διαφορετικές αντιλήψεις, εκπροσωπήσεις και πρωτοβουλίες. Οι συμμετέχοντες ήταν 7 και οι ερωτήσεις συνδέονταν τόσο με την ιστορική-πολιτισμική κληρονομιά όσο και με τη Θαλάσσια Προστατευόμενη Περιοχή της Γυάρου. Οι ερωτήσεις συμπεριελάμβαναν και τη γνώμη των συμμετεχόντων σε ό,τι συνδεόταν με την ανάδειξη της πολιτισμικής και φυσικής ταυτότητας της ΠΠ.

Η ποιοτική έρευνα είναι μια θεσιακή δραστηριότητα (situated activity), η οποία τοποθετεί τον παρατηρητή στον κόσμο. Αυτή συνίσταται σε ένα σύνολο ερμηνευτικών και υλικών πρακτικών, οι οποίες κάνουν τον κόσμο ορατό. Αυτές οι πρακτικές μετασχηματίζουν τον κόσμο. Μετατρέπουν τον κόσμο σε μια σειρά από αναπαραστάσεις του εαυτού, συμπεριλαμβανομένων των σημειώσεων πεδίου, των συνεντεύξεων, των συνομιλιών, των φωτογραφιών, των μαγνητοφωνήσεων και των σημειώσεων σε ημερολόγια. Σε αυτό το επίπεδο, η ποιοτική έρευνα περιλαμβάνει μια ερμηνευτική, νατουραλιστική προσέγγιση στον κόσμο (Ισαρη & Πούρκος, 2015, pp.13-14). Αυτό σημαίνει ότι οι ποιοτικοί ερευνητές μελετούν τα πράγματα στο φυσικό τους πλαίσιο, επιχειρώντας να δώσουν νόημα ή να ερμηνεύσουν τα φαινόμενα με όρους των νοημάτων που οι άνθρωποι δίνουν σε αυτά (Denzin & Lincoln, 2005).

Ιδιαίτερη έμφαση δόθηκε, μέσω των ερωτήσεων, στη μορφή και τη δομή του υλικού της ερμηνείας περιβάλλοντος που θα πλασιώνει την έρευνα και θα αποτελούσε μέρος της ιστοσελίδας "Gyargos-Story" και ειδικότερα των ενοτήτων Εικονικά και Βιβλιοθήκη. Σε ερωτήματα που συνδέονταν με καινοτόμα πεδία, όπως αυτό της Ακουστικής Οικολογίας και των ηχοτοπίων, οι συμμετέχοντες εκδήλωσαν ιδιαίτερο ενδιαφέρον, αναγνωρίζοντας ότι ο ήχος σε συνδυασμό με την εικόνα μεταφέρει άμεσα και ρεαλιστικά τα χαρακτηριστικά μιας περιοχής. Με την ολοκλήρωση και ανάρτηση του υλικού στην ιστοσελίδα και στο πλαίσιο αξιολόγησής του, επισημάνθηκε από το δείγμα των ερωτηθέντων ότι η δυσκολία επίσκεψης της περιοχής περιορίζει τη δυνατότητα πρόσληψης πληροφορίας στο ευρύ κοινό και ότι με τη χρήση του οπτικοακουστικού υλικού και των αφηγημάτων που δημιουργήθηκαν επιτεύχθηκε ο στόχος της εικονικής ξενάγησης στη Γυάρο. Θετικές αναφορές έγιναν για τα ηχοτοπία που είτε συνδυαστικά με την ξενάγηση, είτε με τα βίντεο, είτε αυτόνομα, δημιούργησαν βιωματικές μνήμες από το παρελθόν, έγειραν συναισθήματα και δημιούργησαν εμπειρίες για τη Γυάρο, την ιστορία και τη φύση της.

2.2. Επισκέψεις πεδίου

Η επίσκεψη στο νησί της Γυάρου είναι ιδιαίτερα δύσκολη και πολλές φορές τα καιρικά φαινόμενα απομονώνουν το νησί για μεγάλα διαστήματα, ιδιαίτερα κατά την περίοδο του χειμώνα (Εικόνα 2). Στο πλαίσιο της έρευνας πραγματοποιήθηκαν τέσσερις επισκέψεις με στόχο να επισκεφθεί και γνωρίσει η ερευνητική ομάδα το νησί, να χαρτογραφήσει τις διαδρομές, να καταγράψει τη βιοποικιλότητα, να συγκεντρώσει οπτικοακουστικό υλικό καθώς και να συνεργαστεί με τους άλλους εταίρους του έργου Leader ώστε συντονισμένα να σχεδιαστούν οι στάσεις, οι διαδρομές, τα σημεία ενδιαφέροντος. Το νησί της Γυάρου, στο μεγαλύτερο μέρος του είναι δύσβατο και η παρουσία έμπειρων ξεναγών/φυσιοδιφών/ερευνητών ήταν αναγκαία για τη διάσχιση του. Το υλικό που συγκεντρώθηκε από τις επισκέψεις πεδίου κάλυψε δύο εποχές, άνοιξη και χειμώνα ώστε να παρουσιαστεί η διαφορετικότητα των (ηχο)τοπίων. Λόγω της δυσκολίας πρόσβασης, της επικινδυνότητας επίσκεψης κάποιων κτιρίων και των περιορισμένων επισκέψεων χρησιμοποιήθηκε αξιόπιστος εξοπλισμός ώστε να συγκεντρωθεί επαρκές υλικό παρά τη χρονική πίεση. Για τις επισκέψεις πεδίου είχαν ενημερωθεί οι αρμόδιες υπηρεσίες και είχαν εκδοθεί ειδικές άδειες από τη Μονάδα Διαχείριση-ΟΦΥΠΕΚΑ, όπου αυτό απαιτείτο. Κατά τη διάρκεια των επισκέψεων πεδίου, συγκεντρώθηκε το οπτικοακουστικό υλικό το οποίο αφορούσε σε όλα τα σημεία της διαδρομής (φωτογραφίες, βίντεο, ηχητικά αρχεία) και ακολουθούσε την κυκλική αποτύπωση των σημείων, με τη λογική της «οπτικής αναπαράστασης» κάθε σημείου σαν να διασχίζεται από περιπατητή. Αυτό προσέδωσε ρεαλιστική διάσταση στο όλο εγχείρημα (Ihde, 2001, pp. 18-23).



Εικόνα 2. Προσεγγίζοντας τη Γυάρο

2.3. Καταγραφή βιοποικιλότητας και χαρτογράφηση

Τα υλικά που χρησιμοποιήθηκαν για την καταγραφή της χλωρίδας ήταν: GPS Garmin 64s για την καταγραφή των σημείων, κλείδες αναγνώρισης, οδηγός της ελληνικής χλωρίδας, online οδηγός για τα αρθρόποδα, φωτογραφική μηχανή και κινητό τηλέφωνο για λήψη φωτογραφιών και tablet για τη συμπλήρωση στοιχείων και πρωτοκόλλων. Το GPS χρησιμοποιήθηκε και για τον γεωπροσδιορισμό των σημείων καταγραφής. Το κάθε σημείο, από τα 31 της διαδρομής, κωδικοποιήθηκε με αύξων αριθμό από την πρώτη στάση σε πορεία, ενώ αντίστοιχα τα σημεία ενδιαφέροντος κωδικοποιήθηκαν και ονομάστηκαν βάση των ιδιαίτερων χαρακτηριστικών τους (φυλακές, νοσοκομείο, νεκροταφείο κρατουμένων, φυσική πηγή, σημεία βιοποικιλότητας, σημεία θεάς, ξερολιθιά κ.ά.). Η μορφή των συντεταγμένων ήταν σε υπόβαθρο WGS 84. Το αρχείο συντεταγμένων αποθηκεύτηκε σε μορφή .gpx το οποίο επεξεργάστηκε με το πρόγραμμα Google Earth Pro και στη συνέχεια πραγματοποιήθηκε η χαρτογράφηση. Ακολουθήθηκε χρωματικός κώδικας με ενιαία αρίθμηση, κίτρινη για τα σημεία ηχοληψίας, μπλε για της υποθαλάσσιες διαδρομές και κόκκινο για τις κλειστές για το κοινό (λόγω επικινδυνότητας) προκείμενου να καθίσταται εύκολα διακριτό. Τα σημεία αυτά μεμονωμένα ή ως σύνολο (ηχο)διαδρομής αποτελούν μέρος διαδραστικού χάρτη στην ιστοσελίδα "Gyarus-Story", στην ενότητα «Εικονικά», μέσω του οποίου ο επισκέπτης μπορεί να επιλέξει δυναμικά και ευέλικτα ποια σημεία θέλει να «επισκεφτεί».

Η καταγραφή των ειδών συνοδεύεται από φωτογραφικό υλικό ώστε να είναι πιο εύκολη η αναγνώριση, για την οποία χρησιμοποιήθηκαν on-line κλείδες. Ως αποτελέσματα της έρευνας στο πεδίο καταγράφηκαν σημαντικά ευρήματα με πολύ μεγάλη ποικιλία προστατευόμενων ειδών σε διαφορετικές εποχές του έτους (άνοιξη, χειμώνας). Ενδεικτικά αναφέρονται: α. αποικία της ορχιδέας *Orchis papilionaceae*, β. ταξιανθίες του γένους *Fritillaria*, γ. χασμόφυτα *Centaurea raphanina subsp. mixta* με έντονη βόσκηση και ε. πολλά *Sedum* που απλώνονται πάνω στα ερείπια των κτιρίων. Σε ό,τι αφορά στην πανίδα καταγράφηκαν γαστερόποδα όπως το *Albina*, ξενικά οικόσιτα θηλαστικά όπως Λαγός (*Lepus europeus*), κατσίκια και χοίροι, καθώς και αυτόχθονα είδη όπως οι φώκιες στις θαλάσσιες σπηλιές. Σε ό,τι συνδέεται με τη βιοποικιλότητα και τα ηχοτοπία της Γυάρου καταγράφηκαν είδη ορνιθοπανίδας που συναντώνται στο νησί. Ο εμβληματικότερος ήχος στην ηχητική βιβλιοθήκη της έρευνας είναι αυτός του Μύχου (*Puffinus puffinus*). Ο μύχος είναι σπάνιο θαλασσοπούλι και στη Γυάρο φιλοξενούνται περίπου 2.000 ζευγάρια του είδους τα οποία ζουν σε αποικίες στις βραχώδεις ακτές και τους βραχώδεις σχηματισμούς της.

2.4. Ηχογραφήσεις

Οι ηχογραφήσεις στη Γυάρο πραγματοποιήθηκαν σε δύο διαφορετικές χρονικές περιόδους, την άνοιξη και τον χειμώνα, συγκεκριμένα στις 23-24 Μαΐου 2022 και στις 24-25 Φεβρουαρίου 2023 (Εικόνα 3). Στα περισσότερα επιλεγμένα σημεία ενδιαφέροντος εφαρμόστηκαν δύο διακριτά και συμπληρωματικά συστήματα ηχοληψίας. Συγκεκριμένα, χρησιμοποιήθηκε μία στερεοφωνική τεχνική ηχογράφησης βασισμένη στη σχεδόν συμπτωτική τεχνική O.R.T.F. (Office de Radiodiffusion-Télévision Française), καθώς και ένα σύστημα τρισδιάστατης ηχητικής αποτύπωσης με τη μέθοδο Ambisonics. Για την κάλυψη πιο εξειδικευμένων ηχογραφήσεων, αξιοποιήθηκαν ειδικά μικρόφωνα όπως γεώφωνο (π.χ., εντός του κτηρίου των φυλακών, στην αίθουσα λογοκρισίας, στην απομόνωση) και υδρόφωνο (για ηχογραφήσεις μέσα στο πηγάδι και στη θάλασσα). Τα παραπάνω μικρόφωνα χρησιμοποιήθηκαν είτε αυτούσια είτε συνδυαστικά με τις δύο βασικές τεχνικές ηχογράφησης, για καλύτερα και εντυπωσιακότερα αποτελέσματα.

Κύριος στόχος της ηχογράφησης ήταν η συλλογή ηχητικών δειγμάτων υψηλής πιστότητας και ποιότητας από τα σημεία καταγραφής, με σκοπό την ενσωμάτωσή τους στην ιστοσελίδα. Τα ηχητικά αυτά δεδομένα προορίζονταν να αξιοποιηθούν στην ενότητα Εικονική Ξενάγηση, είτε ως ηχοτοπία περιορισμένης χρονικής διάρκειας, είτε συγχρονισμένα με τις κινηματογραφήσεις από τα ίδια σημεία ενδιαφέροντος, ή, τέλος, με σκοπό να ενσωματωθούν αυτούσια στην ενότητα Ηχητική Βιβλιοθήκη ως ηχοτοπία μεγαλύτερης χρονικής διάρκειας.

Η διάρκεια κάθε ηχογράφησης δεν ήταν σταθερή, αλλά κυμαινόταν από 5 έως 10 λεπτά, ανάλογα με την ηχητική ποικιλομορφία του εκάστοτε σημείου ενδιαφέροντος, τη σημασία του από ιστορική άποψη (π.χ. κορυφογραμμές, φυλάκια, παλιοί καταυλισμοί, παραλίες κ.λπ.), καθώς και τη συμβολή του σημείου στο συνολικό αφήγημα. Οι ηχογραφήσεις στα σημεία ενδιαφέροντος πραγματοποιήθηκαν με «παθητική» προσέγγιση, δηλαδή με ελάχιστη ηχητική παρέμβαση από την ομάδα πεδίου, προκειμένου να μη διαταραχθεί το ηχοτοπίο. Για την πληρέστερη αποτύπωση του ηχητικού περιβάλλοντος, η ομάδα παρέμενε για αρκετό χρονικό διάστημα ήσυχη και ακίνητη πριν από κάθε καταγραφή, επιτρέποντας στο ηχοτοπίο να επιστρέψει στη φυσική του κατάσταση (Λουφόπουλος κ.ά., 2012), ενώ η μετακίνηση σε κάθε σημείο γινόταν χωρίς έντονες

ομιλίες και οχλαγωγίες. Στη συγκεκριμένη διαδικασία εκπαιδεύτηκαν όλα τα μέλη της ομάδας πεδίου, ακόμα και οι συνοδοί από το WWF.

Για τις ηχητικές καταγραφές στα 31 σημεία της Γυάρου, ως κύριο σύστημα ηχογράφησης επιλέχθηκε το Ambeo VR Mic της Sennheiser, το οποίο αποτελείται από τέσσερις διακριτές καρδιοειδείς κάψες KE 14 σε τετραεδρική διάταξη, ενσωματωμένες σε ένα ενιαίο, συμπαγές σώμα, και χρησιμοποιεί την τεχνική Ambisonics (Malham & Myatt, 1995, pp. 58-70). Αυτή η μέθοδος επιτρέπει την περιφερειακή και τρισδιάστατη καταγραφή του ηχοτοπίου (surround - 360°) με ένα ευέλικτο μικροφωνικό σύστημα. Το σύστημα αυτό επιλέχθηκε επειδή επιτρέπει στο στάδιο της μεταπαραγωγής να επιλεγεί ο τρόπος αναπαραγωγής των ηχογραφήσεων, δηλαδή αν θα αναπαραχθούν μονοφωνικά, στερεοφωνικά, surround 5.1 ή ακόμα και binaural για ακουστικά (Frank, Zotter, Sontacchi, 2015). Αυτό θεωρήθηκε ιδιαίτερα σημαντικό, καθώς, παρά το γεγονός ότι οι ηχογραφήσεις έχουν αποδοθεί κυρίως σε στερεοφωνικό σχήμα, υπάρχει η δυνατότητα αναπαραγωγής τους και σε binaural (αμφιωτική) μορφή για τρισδιάστατη ακουστική εμπειρία μέσω ακουστικών. Αυτή η μορφή είναι απαραίτητη για μια πληρέστερη ηχητική απεικόνιση, ειδικά σε εφαρμογές που απαιτούν υψηλό επίπεδο εμβύθισης (immersion) (Μαραγκός, Μνιέστρης, Επιτήδειος, 2021).

Ως δευτερεύον σύστημα ηχοληψίας επιλέχθηκε η σχεδόν συμπτωτική (near coincident) στερεοφωνική τεχνική O.R.T.F. σε διάταξη 110° και απόσταση 17 εκατοστών μεταξύ των καψών των μικροφώνων, με καρδιοειδή πολικά διαγράμματα (Rumsey & McCormick, 2009, pp.458-460). Η στερεοφωνική εικόνα που αποδίδει η συγκεκριμένη διάταξη είναι αρκετά ευρεία και ευχάριστη και παρέχει σωστή στερεοφωνική αποτύπωση. Ακόμα, επιτυγχάνει καλύτερο ολικό συμβιβασμό μεταξύ χώροτοποθέτησης και ακρίβειας ειδώλου. Τα μικρόφωνα που χρησιμοποιήθηκαν ήταν τα Line Audio CM4.

Για την ηχογράφηση με τη μέθοδο Ambisonics επιλέχθηκε ο τετρακάναλος καταγραφέας της Sound Devices: Mix Pre 6 και για την ηχογράφηση με την τεχνική O.R.T.F. επιλέχθηκε ο δικαναλικός καταγραφέας της Tascam DR-100. Σε όλες τις ηχογραφήσεις κρίθηκε απαραίτητη η χρήση ειδικού αντιανεμικού θώρακα για να αποφευχθεί οποιαδήποτε παραμόρφωση στα διαφράγματα των μικροφώνων λόγω ανέμου. Τα μικρόφωνα τοποθετήθηκαν σε ύψος περίπου 1.7 μέτρων, ώστε να αποτραπούν οι ηχητικές ανακλάσεις από το έδαφος και να αποδοθεί μια πιο ρεαλιστική ηχητική εικόνα, προσεγγίζοντας το ύψος των αυτιών ενός μέσου ανθρώπου. Τέλος, όλες οι ηχογραφήσεις που χρησιμοποιήθηκαν, είτε στην ενότητα Εικονική Ξενάγηση είτε στη Βιβλιοθήκη, υπέστησαν ελαφριά και ομοιόμορφη επεξεργασία. Η κύρια προτεραιότητα κατά την επεξεργασία ήταν η διατήρηση της ρεαλιστικής απόδοσης του ηχοτοπίου, ώστε να αντικατοπτρίζεται με ακρίβεια η φυσική ακουστική εμπειρία.



Εικόνα 3. Η ομάδα καταγραφής στο πεδίο

2.5. Δημιουργία ψηφιακού υλικού

Με το οπτικοακουστικό υλικό που συγκεντρώθηκε, δημιουργήθηκε μία βάση δεδομένων για κάθε σημείο με φωτογραφίες και ηχητικά αρχεία. Στηριζόμενοι στη βιβλιογραφική έρευνα, το υλικό αυτό ταυτοποιήθηκε με βιβλιογραφικές αναφορές και γραπτά ή υλικά τεκμήρια και μετά την επεξεργασία του αναρτήθηκε στην ιστοσελίδα του προγράμματος και ειδικότερα στις θεματικές ενότητες Εικονικά και Βιβλιοθήκη. Το υλικό αυτό συμπεριελάμβανε το διαδραστικό χάρτη με τα 31 σημεία της (ηχο)διαδρομής, φωτογραφικό υλικό σε κάθε σημείο καθώς και στις ειδικές θεματικές της Βιβλιοθήκης (ίχνη και μνήμες, σκουριά, ύδωρ, ερείπια και κτίσματα, θαλάσσια πανίδα, χερσαία χλωρίδα-πόες, χερσαία χλωρίδα-δέντρα, χερσαία πανίδα). Παράλληλα, στο πλαίσιο της ερμηνείας περιβάλλοντος, δημιουργήθηκαν 31 αφηγήματα, ένα για κάθε σημείο καθώς και ένα

συνολικό κεντρικό αφήγημα αποτελούμενο από κινηματογραφήσεις και διαφορετικά ηχοτοπία της Γυάρου με υπότιτλους. Παράλληλα, σε κάθε σημείο ο επισκέπτης εκτός από το φωτογραφικό υλικό, τα αρχεία των ηχοτοπιών σε κάθε εποχή (άνοιξη, χειμώνας) και τις ηχητικές ξεναγήσεις, μπορεί να επιλέξει να παρακολουθήσει και σύντομο στατικό βίντεο με (ηχο)τοπία, μια προσέγγιση που μεταφέρει με αναστοχαστικότητα νοητά και βιωματικά τον επισκέπτη στις εικόνες, στις μνήμες και στα ηχοτοπία του παρελθόντος (Wei & Luo, 2019). Τα βίντεο αυτά αποτελούν υλικό που έχει καταχωρηθεί επίσης και σε ειδικό κανάλι στο Youtube για θέαση εκτός της ιστοσελίδας.

Αντίστοιχα, στην ενότητα Βιβλιοθήκη έχουν αναρτηθεί ηχοτοπία του νησιού, μεγαλύτερης χρονικής διάρκειας από την ενότητα Εικονικά δίνοντας τη δυνατότητα της πληρέστερης ακρόασης των ηχοτοπιών. Αναρτήθηκαν επίσης, κάποιοι ήχοι βιοποικιλότητας όπως «κραυγές» του μύχου, που αποτελεί την πλέον χαρακτηριστική ηχητική πηγή της Γυάρου, μεταφέροντάς μας εικονικά στις αποικίες του. Αξιοσημείωτο δείγμα αποτελεί και ένας ηχογραφημένος ήχος μέσα από το κεντρικό κτίριο των φυλακών, στον μακρύ διάδρομο, όπου το άγγιγμα των δαχτύλων στα τούβλα προκαλεί τη θρυμματισμένη πτώση τους στο έδαφος³³, αναδεικνύοντας την εγκατάλειψη αλλά και την κατάρρευση στα κτίρια των φυλακών (Εικόνα 4).



Εικόνα 4. Ηχογράφιση στο κεντρικό κτήριο των φυλακών

3. Συμπεράσματα-Συζήτηση

Η Ακουστική Οικολογία μπορεί να αποτελέσει σημαντικό εργαλείο για την ερμηνεία και ανάδειξη της φυσικής και πολιτισμικής κληρονομιάς. Οι ανεπτυγμένες μεθοδολογίες καταγραφής και αποτύπωσης επιτρέπουν μια πληρέστερη και ολιστική προσέγγιση, προσδίδοντας σεβασμό, εκτίμηση και βαθύτερη κατανόηση του περιβάλλοντος. Με τη χρήση νέων τεχνολογιών και το συνδυασμό ηχητικών αρχείων με εικόνα (φωτογραφίες και βίντεο) αλλά και με αφηγήματα/ηχητικές ξεναγήσεις δίνεται η δυνατότητα εικονικής βιωματικής επίσκεψης σε περιοχές όπου η πρόσβαση είναι δύσκολη ή υπάρχουν περιορισμοί λόγω θεσμικού πλαισίου. Παράλληλα, η δημιουργία ευέλικτου υλικού που επιλέγει ο χρήστης συνδυαστικά με το συνδυασμό των μέσων που θα τον ξεναγήσουν μετατρέπει το υλικό προσβάσιμο για γενικές και ειδικές ομάδες.

Τα ηχοτοπία της Γυάρου στην παρούσα έρευνα αποτελούν μαζί με το οπτικοακουστικό υλικό και τα αφηγήματα τους κύριους διαμεσολαβητές για την ανάδειξη της πολιτισμικής, ιστορικής και περιβαλλοντικής της ταυτότητας.

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³³ Βλ. Εγκατάλειψη, κατάρρευση φυλακών, διαθέσιμο στο: <https://gyaros-story.gr/vivliothiki/>

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Highlighting natural and cultural heritage through soundscapes - Case study: the marine protected area of Gyaros

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Abstract

The protection of natural and cultural heritage constitutes a challenge for the preservation of memory. Gyaros, a place of imprisonment and exile and a National Marine Protected Area is the case study area. Environmental interpretation facilitates the visitor to become informed, to receive information and data of an area, enabling them to understand its cultural and natural significance within the context of an in-person visit or virtually through digital means. This research constitutes part of a "CLLD-LEADERProgram" and focuses to the creation of awareness material for general and special groups. The compiled material includes: a sound path, soundscapes, photos, 32 different narratives as audio tours, videos with soundscapes as audio backgrounds at different seasons. Additionally, a photographic library and a sound library were created. To capture both the visual and audio material, equipment was used that reliably and realistically recorded the relief of Gyaros and its soundscapes.

The virtual visit to a place and the creation of an (audio) route with the option to select points of interest according to the visitor's preferences creates interaction and a personal, immersive experience. Recording and capturing an entire island with audiovisual material and soundscapes represents a holistic approach to environmental interpretation.

Keywords

Gyaros, Protected Areas, Soundscapes, Narratives, Environmental Interpretation

A watercolor illustration of a dark bird perched on a branch. The bird is dark with a white eye and a long, pointed beak. It is perched on a light-colored branch that runs diagonally across the frame. The background is a soft, light-colored wash with some darker, textured areas suggesting foliage or a natural setting. The text "Soundscapes as a compositional framework" is overlaid in the center of the image.

Soundscapes as a compositional framework

Ηχητικό περιβάλλον και παραδοσιακή μουσική στα ορεινά Πιέρια πριν την ηλεκτροδότηση

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Περίληψη

Ο γράφων πρόλαβε κατά τη δεκαετία του 1960 να γνωρίσει το ηχητικό περιβάλλον της ιδιαίτερης πατρίδας του, των Ριζωμάτων στα ορεινά Πιέρια, μιας περιοχής η οποία λίγο πολύ έμοιαζε με τις περισσότερες της ορεινής ελληνικής υπαίθρου, πριν αυτή γνωρίσει τον εξηλεκτρισμό. Αν εξαιρέσει κανείς τους ήχους της μηχανής εσωτερικής καύσης και τον ήχο της έκρηξης πυρομαχικών, όλοι οι άλλοι ήχοι προέρχονταν από το φυσικό περιβάλλον και από τις ανθρώπινες δραστηριότητες κατά τη χρήση απλών εργαλείων, χωρίς να υπάρχει η χρήση ηλεκτρικής ενέργειας, τόσο στην αναπαραγωγή (ραδιόφωνο, ηλεκτρόφωνο, τηλεόραση) όσο και στην ενίσχυση του ήχου (μεγάφωνα κ.λπ.).

Το ηχητικό περιβάλλον το οποίο αποτελούσε την ακουστική πραγματικότητα για χιλετίες είναι φυσικό να αντανakλάται στη μουσική παραγωγή και στα ιδιαίτερα μουσικά χαρακτηριστικά κάθε τοπικής παράδοσης. Έτσι συμπεριλαμβάνονται στη μελέτη πλην των συνήθων ήχων της ανόργανης φύσης (κεραυνός, αέρας ανά είδος δάσους, νερών ανά είδος ροών κ.λπ.), οι ήχοι της τοπικής πανίδας από πουλιά ή άγρια αλλά και οικόσιτα ζώα, ο ήχος συγκεκριμένων εργαλείων, και βέβαια ο ήχος των εν χρήσει τοπικών μουσικών οργάνων ή τυχόν ο ήχος εκτελεστικών πρακτικών, όπως π. χ. τραγούδι από τεράστια ανδρικά και γυναικεία ημιχόρια σε παλιές τοπικές μουσικές πρακτικές.

Στην παρούσα ανακοίνωση επιχειρείται η καταγραφή των ηχητικών στοιχείων και η ανίχνευση επιρροών και παραλληλισμών με το παραδοσιακό μουσικό ρεπερτόριο της περιοχής. Για τη σύγκριση λαμβάνεται υπόψιν, πέρα από την προσωπική εμπειρία, η μικρή δισκογραφία των χωριών της ευρύτερης περιοχής η οποία εμφανίζει κοινά μουσικά χαρακτηριστικά της στενότερης ιδιαίτερης κατηγορίας της Θεσσαλοπειρωτικής μουσικής παράδοσης. Η ακουστική οικολογία θέτει έμμεσα θέμα ποιότητας των ακουσμάτων. Μετά τις τεράστιες τεχνολογικές και κοινωνικές αλλαγές που επηρέασαν πλέον ακόμα και τις πιο απομακρυσμένες περιοχές της υπαίθρου, μια αναζήτηση αυτού του αρχέγονου ηχητικού περιβάλλοντος, πέρα από τη συμβολή στην ερμηνεία πολλών φαινομένων της παραδοσιακής μουσικής, ίσως μας βοηθήσει να εκτιμήσουμε μια εκδοχή «γνησιότητας» των ακουσμάτων της παράδοσης, αποκαθαρμένης από ηχητικά «σκουπίδια» και κακής ποιότητας ξενόφερτα υλικά.

Λέξεις κλειδιά

Ηχοτοπίο, Πιέρια, εξηλεκτρισμός, παραδοσιακή μουσική

1. Εξηλεκτρισμός και παραδοσιακή μουσική

Από τις αρχές της ελληνικής δισκογραφίας και για πολλές δεκαετίες μέχρι και σχετικά πρόσφατα (εκδόσεις Σίμωνα Καρά, Δόμνας Σαμίου, Γιώργου Αμαργιανάκη, Λάμπρου Λιάβα, Γιώργου Μελίκη κ.ά.) οι καταγραφείς και οι εκδότες παραδοσιακής μουσικής, παρά τη βοήθεια και τις διορθώσεις που προσφέρει η τεχνολογία, θεωρούν και ηχογραφούν ως παραδοσιακό το φυσικό άκουσμα των παλαιών γνωστών οργάνων και των φωνών. Η χρήση οργάνων, όπως π.χ. η ηλεκτρική κιθάρα ή το αρμόνιο, τα οποία έχουν πολύ δρόμο ακόμα μέχρι πιθανόν να καταστούν παραδοσιακά, θεωρούνταν τουλάχιστον ακαλαίσθητη επέμβαση.

Οι αλλαγές που επέφερε ο εξηλεκτρισμός στο ηχητικό τοπίο έχουν ήδη σχολιασθεί από τους ειδικούς των ηχοτοπίων (Schafer 1994, 88). Οι ήχοι του φυσικού άψυχου και έμβιου περιβάλλοντος και των απλών ανθρώπινων δραστηριοτήτων ήταν για χιλιετίες η ηχητική πραγματικότητα σε όλες τις προβιομηχανικές κοινωνίες. Μια σχετικά νέα προσθήκη αποτέλεσε η έκρηξη πυρομαχικών και βέβαια μεγάλη αλλαγή έφερε η βιομηχανική εποχή, κυρίως με τη μηχανή εσωτερικής καύσης. Η επόμενη μεγάλη αλλαγή συμβαίνει με τον εξηλεκτρισμό, με την αναπαραγωγή μουσικού ή άλλου ηχητικού υλικού (ραδιόφωνο, ηλεκτρόφωνο, τηλεόραση, πικάπ κ.λπ.) με μεγάφωνα. Αυτή η αλλαγή συνέβη σχετικά γρήγορα και όχι πάντα με βάση κανόνες καλαισθησίας και κομψότητας. Η χρήση του ηλεκτρισμού στην καταγραφή, αναπαραγωγή και κυρίως στην ενίσχυση του ήχου, ιδίως παλαιότερα με τις κακής ποιότητας συσκευές και τεχνικές (βλ. το λεγόμενο «eco», τα φίλτρα των ενισχυτών, το ηλεκτρικό μπουζούκι, το συνθεσάιζερ), επέφερε δραματικές αλλαγές στο ηχητικό αποτέλεσμα που παράγεται κατά την επιτέλεση της παραδοσιακής μουσικής σε όλο το γεωγραφικό φάσμα τοπικών παραδόσεων. Αν προσθέσουμε και την ευκολία διακίνησης και εισαγωγής νέων εμπορευματοποιημένων μουσικών ειδών ρεπερτορίου με την όλο και ευκολότερη προσιτότητα σε ακρόαση από ηλεκτρονική αναπαραγωγή ηχογραφήσεων (βλ. π.χ. τα «νεοδημοτικά», τις μιμήσεις του «σκυλάδικου»), συνήθως κακής ποιότητας, καταλαβαίνουμε ότι οι αλλαγές δεν ήταν πάντα προς βελτίωση και δημιουργική αφομοίωση, αλλά συχνότερα προς αλλοίωση και ζημία του παλαιότερου και δουλεμένου επί μακρόν τοπικού μουσικού χρώματος. Η έννοια της «ηχορύπανσης» πάνω στο παλαιότερο παραδοσιακό άκουσμα, τόσο με ανεπιθύμητο και κακόγουστο ήχο, όσο και με άκριτες έως κακές μουσικές μιμήσεις, είναι δυστυχώς μια υπαρκτή πραγματικότητα.

2. Το ηχοτοπίο των ορεινών Πιερών

Για την παρούσα εισήγηση τέθηκε προς μελέτη το ηχητικό περιβάλλον μιας περιοχής με περίπου μια δωδεκάδα χωριών των ορεινών Πιερών για την προ του εξηλεκτρισμού της δεκαετίας του 1960. Πρόκειται για ένα περιβάλλον ελληνικής αγροτικής υπαίθρου ενταγμένου από μουσικολογικής πλευράς στη λεγόμενη κατά τον Σαμουέλ Μπομπωβύ θεσσαλοηπειρώτικη παράδοση (Μπομπωβύ 1984, 39). Προφανώς όμοιες παρατηρήσεις μπορούν να γίνουν σε πολλά άλλα μέρη αυτής της ευρύτερης μουσικής περιοχής. Το ερώτημα που τίθεται είναι: τί άκουγε ο κάτοικος μιας τέτοιας περιοχής μέχρι και εκείνη την εποχή και πώς αυτό το ηχητικό τοπίο επηρέαζε τη μουσική του έκφραση, κυρίως στην εκτέλεση της κοσμικής παραδοσιακής μουσικής και λιγότερο της Ψαλτικής.

Στο πρώτο μέρος της εισήγησης θα επιχειρηθεί μια καταγραφή αυτού του πρωτογενούς ηχοτοπίου, η οποία σε μεγάλο βαθμό βασίζεται στην προσωπική εμπειρία του γράφοντος, καθώς πρόλαβε αυτή την προ εξηλεκτρισμού εποχή, αλλά και παρακολούθησε επί μέρους παραμέτρους της σταδιακής αλλαγής. Έχοντας υπόψιν το μουσικό υλικό από προσωπική μουσικολογική έρευνα και γνώση, επίσης φιλολογικό υλικό από προσωπική συλλογή δημοτικών τραγουδιών στα Ριζώματα Ημαθίας και μελετώντας τα με τα εργαλεία της τεχνικής θεωρητικής μουσικής ανάλυσης, θα επιχειρηθεί η αναζήτηση κάποιων παραλληλισμών και συσχετίσεων. Μικρή βοήθεια προσφέρει και η πενιχρή δισκογραφία όπως και σποραδικές διαδικτυακές αναρτήσεις.

2.1. Ήχοι φυσικών φαινομένων

Παρατίθεται ένας στοιχειώδης κατάλογος φυσικών ήχων, κοινός βέβαια σε πολλά όμοια ορεινά περιβάλλοντα: βροντή κεραυνού, καταιγίδα, ήχοι βροχής ανά αντικείμενο και ανά ένταση πρόσκρουσης, άνεμος σε φύσημα ανά δέντρο (σε πεύκα - συριγμός, σε οξιές και δρύες - μέσος ήχος σε καρυδιές -κροταλισμός, σε πλατάνια - πλαταγισμός κ.ο.κ.), ρέματα - ροές νερού ανά ποσότητα έως μεγέθους ποταμού και καταρράκτη, ήχος φωτιάς έως ήχος καψαλού (δασικής πυρκαγιάς), κατολίσθηση, σπάσιμο κλαδιών.

2.2. Ζώα άγρια και έντομα

Ηχητικό αποτύπωμα από την άγρια τοπική πανίδα αφήνουν: Λύκοι, τσακάλια, αλεπούδες, σκίουροι που ροκανίζουν, σύρσιμο και φύσημα φιδιών, σύρσιμο σαύρας, βατράχια, τζιτζίκια (με 5 - 6 περίπου μοτίβα), ακρίδες, σαράκια, τριζόνια, μέλισσες, σφήκες, ντάβανοι (μεγάλα έντομα δάσους), τσαγκαράδια (κάνθαροι), στρέγκλα (οίστρος βοοειδών) κ.ά.

2.3. Ζώα ήμερα

Από τα ήμερα ζώα σημειώνονται φωνές και ήχοι κίνησης από σκυλιά, αγελάδες, γαϊδούρια, μουλάρια, άλογα, γουρούνια (και άγρια), κατσίκια, πρόβατα, κότες-κοκόρια, γάτες, σπανιότερα πάπιες, καλπασμός, πέταγμα, σύρσιμο, φρόμαγμα (ρουθούνισμα), άλλοι ήχοι, όπως χτύπημα κεράτων, ποδοβολητά, καλπασμός κ.λπ.

2.4. Πουλιά

Οι ήχοι των πουλιών πρωταγωνιστούν σε όλα τα ηχοτοπία. Τα πιο συνηθισμένα είδη που ακούγονται στα συγκεκριμένα χωριά είναι: Τζ'βίκια (γεράκια), όρνια (γύπες – μαρτυρούνται μέχρι το 1950), αηδόνια, κοτσύφια, κούκοι, καρδερίνες, σπουργίτια, σπίνι, κορυδαλλοί, δρυοκολάπτες, κουρούνες, κοράκια, κάργιες, καρακάξες, γκιώνηδες, κουκουβάγιες, πέρδικες, τρυγόνια - τουρτούρες, χελιδόνια 2-3 είδη, τσίχλες, κίσσες, παπαδίτσες, δεκαοχτούρες, κοκκινογκούηδες (κοκκινολαίμηδες), τσιγκλιτάρες (δρυοκολάπτες). Ξεχωριστό άκουσμα έχει το πέταγμα του κόρακα ως ισόχρονο σκούπισμα, το πέταγμα δεκαοχτούρας ως σφύριγμα, ο θορυβώδης της πέρδικας και άλλα λιγότερο χαρακτηριστικά πετάγματα.

2.5. Ανθρώπινοι ήχοι

Αυτονόητα καταγράφονται οι ήχοι της ανθρώπινης βιολογικής δραστηριότητας: ομιλία, κλάμα, γέλιο, αναστεναγμός, βήχας, λυγμός (βρεφικά, παιδικά, ανδρικά γυναικεία, γοερά, σιγανά), παλαμάκια, παιγνιώδεις ήχοι εγκλωβισμού αέρα με παλάμη πίσω από γόνατο και μασχάλη, συριγμός σε κούφια παλάμη (μίμηση «κουκουβάου»), συγκεκριμένα παραγγέλματα βοσκής κ.λπ., σφυρίγματα, τρεχάλα, βήματα ανά έδαφος (σε ξερό, σε λάσπες, σε φυτοκάλυψη), ήχοι πλήθους και μαζικών τελετών, όπως σχολείου, εκκλησίας (όπου συνήθεις, απλές και μονοφωνικές ψαλμωδίες σε γάμους, βαφτίσεις, κηδείες), ομιλίας πλήθους σε πανηγύρια, ονομαστικές εορτές, εθμικές τελετές - Απόκριες κ.λπ., παιγνίδια παιδικά ή άλλα, καφενείο, περιστασιακά εκδηλώσεις στην «πλατέα», σε σεργιάνια, μουςαμπέτια, επισκέψεις, νυχτέρια, στην Κυριακάτικη ή πανηγυριώτικη βόλτα.

2.6. Ηχογόνα αντικείμενα

Σε σχέση με το περιβάλλον διαβίωσης και της χρήσης συγκεκριμένων εργαλείων σημειώνονται ήχοι από σκεύη, ήχοι εργασιών: σκάψιμο, μπατάνισμα, κοπή, ξεφλούδισμα, σκίσιμο, λιάνισμα κοπή με τσεκούρι κ.λπ., κρούσεις και θραύσεις με σφυρί, βαριά κ.λπ., σπάσιμο πέτρας, πριόνισμα, ροκάνισμα, τρόχισμα, ψαλίδισμα, κάρφωμα, όργωμα, πλύσιμο, τίναγμα καρυδιάς, ξεσπύρισμα, νερόμυλος, μύλος καφέ, σπάνια ήχος χειροκίνητης ραπτομηχανής, τσιρκίκι, αμόνι, λανάρα, ήχοι ξυλόσομπας ή τζακιού, ήχοι βρασμών, θραύσεων, σχισίματος, σπάσιμο γυαλιού, τριγμοί και γδούποι αντικειμένων, πέταλα ζώων, κουδούνι και σφυρίχτρες δημοτικού σχολείου, αργαλειός, παλιά ρολόγια και ξυπνητήρια, κοσμήματα – γιορντάνια, νομίσματα κ.λπ.

2.7. Μουσικά όργανα

Τα μουσικά όργανα και ψευδοόργανα, υπό στενή και ευρεία έννοια, χαρακτηρίζουν πάντα κάθε παράδοση και περιλαμβάνουν όλα εκείνα τα αντικείμενα δια των οποίων επιδιώκεται παραγωγή οργανωμένου ήχου. Καταγράφονται: γκάιντα, απλή γκαϊντοφλόδρα, φλογέρα, «τάμπουρας» (παλαιότερα), τοξωτή λύρα (παλαιότερα), σπανίως επείσακτα νταούλια, σάλπιγγα ταχυδρόμου, καραμούζα από φλούδα καστανιάς και διπλό γλωσσίδι, τσαμπούνες από καλάμια έως και από στελέχη φυτού δημητριακών, ντουφέκια (γάμος, χαροκόπι, σινιάλα), σκεπάρια στο «λάλημα στέγης σπιτιού», κουδούνια στα ραγκατζάρια, φύλλο καρυδιάς, τσατσάρα, τσουνγκρισμα ποτηριών, κομπολόγια, ψευδοέγχορδα παιγνίδια με ίνες καλαμιού, παλαμάκια, χτυπήματα ποδιών. Επίσης η καμπάνα της εκκλησίας σε τρία μοτίβα (κοινό της Ακολουθίας σε 4/4: $\frac{1}{4}$ - $\frac{1}{4}$ - $\frac{1}{2}$), πένθιμο κηδείων και ταχύ συναγερμού (σε πυρκαγιές) και όμοιο ταχύ πανηγυρικό τα Φώτα και την Ανάσταση, θυμιατό, τάλαντο (παλαιότερα), κουδούνια ζώων (κυπριά, τράκες, τσιουκάνια). Σημειώνεται μια ξεχωριστή εμπειρία για χορό σε γάμους ή γιορτές εντός δωματίου με παλιό ξύλινο πάτωμα στηριγμένου σε δοκάρια σε ταχύ τετράσημο. Ο συντονισμός του πατώματος μαζί με τον ήχο των βημάτων να λειτουργεί ως ιδιότυπο κρουστό κοντά στη γκάιντα ή τις φωνές, δημιουργούσε μια ιδιαίτερη ένταση στην αίσθηση.

3. Η νοηματοδότηση του ήχου και της μουσικής στις συγκεκριμένες κοινότητες

Η κοινή λειτουργία της ακοής για τη συνήθη βιολογική και κοινωνική χρήση αποδίδεται χαρακτηριστικά στην τοπική έκφραση: «*νάμαστε καλά, να ακουγόμαστε*» (δηλαδή να είμαστε ζωντανοί, να δρούμε και αυτό να γίνεται αντιληπτό από τους άλλους δια της ακοής). Κοινή είναι η έκφραση για το καλό παίξιμο των οργάνων: «*Η γκάιντα κελαηδάει...*», όπως και η συνήθης παρομοίωση με αηδονία των καλών τραγουδιστών.

3.1. Ήχοι στο Δημοτικό Τραγούδι

Ένα χαρακτηριστικό πεδίο για να καταδειχτεί το πώς και ποιά σημασία δίνεται στο ηχητικό γεγονός σε σχέση και με τη μουσική, είναι η συλλογή αναφορών περί ήχου και ειδικά περί μουσικών οργάνων, τραγουδιού κ.λπ. μέσα στα Δημοτικά Τραγούδια της περιοχής. Σταχυολογούνται μερικές χαρακτηριστικές περιπτώσεις (προσωπική συλλογή, βλ. και Βαϊνιάς 2017).

Φωνές, όργανα:

- *Χαριτωμένη συντροφιά με λέει να τραγουδήσω...*
- *Για φέρτε με τον **τάμπουρα** και το **καραντουζένι**,*
- *Να πώ τραγούδια **χλιβερά** και παραπονεμένα ...*
- *Από την Πόλη κίνησα παίζοντας το **λιονγκάρι**...*
- *Ποιος ήταν που **τραγούδησε** και εστάθη το καράβι...*
- *Βόσκε, Κώστα μ', τα πρόβατα και **λάλει** τη φλογέρα,*
- ***Λάλει την και τριλάλει** την σε τρεις σκοπούς να παίζεις...*
- *Ποιος θελ' ν' ακούσει **κλιάμματα**, δάκρυα και μυριολόϊα...*

Δέντρα, νερά:

- *Ακούω τα πεύκα πως **βροντούν** και τις οξυές πως **θάζουν**...*
- *Και τα καημένα έλατα πως **σκούζουν** πως **φωνάζουν**...*
- *Πάψε, θάλασσα μ' το **θαγμό**, πάψε και τη φουρτούνα...*
- *Για μένα **σκούζει** ο ποταμός και δέντρα ξεριζώνει...*

Κρούσεις κ.λπ.:

- *Και (**α**)**χοβολιά** στις φάλαγγες του ντουφεκιού μου ο **βρόντος**...*
- ***Αχός βαρύς ακούγεται** πολλά ντουφέκια πέφτουν...*
- *Κι απ' τις κλωτσιές από 'ριχνεν **βροντούσε** το παζάρι...*
- *Όλοι πααίνουν κέρασμα κριάρια με **κουδούνια**...*
- ***Γρίτσι γρίτσι** το πριόνι, όσον πάει και μεγαλώνει...*

Πουλιά:

- *Ένα είν'τ' αηδόνι κι αυτό το Μάη **λαλεί**...*
- ***Άκου** το πουλί, Μπηγίνα, πως **μορφολαλεί**...*
- *Εκεί **λαλούν** οι πέρδικες κι **αντικοτούν** τα πλάϊα...*
- *Το **λέν** οι κούκοι στα βουνά κι οι πέρδικες στα πλάϊα...*
- *Τον **λέει** κι ο πετροκότσυφας στα κλέφτικα λημέρια...*
- *Με γέλασε μια χαραή / της άνοιξης τ' αηδονία/ με γέλασαν και **μ' είπανε**...*
- *Τ' έχεις καημένε κόρακα και **σκούζεις** και **φωνάζεις**...*
- *Ακούω μιας πέρδικας **λαλιά**, πως σκούζει πως φωνάζει...*
- ***'Κούγω** τ' αηδόνια πως **λαλούν** και τα πουλιά το **λέγουν**...*
- ***'Κούγω** τον κούκο μαναχόν, το **λέει σαν μυριολόϊ**...*

4. Ηχοτοπίο και μουσική στα Πιέρια

Η απόπειρα να συσχετισθεί το εκάστοτε ηχοτοπίο με την τοπική μουσική παραγωγή ξεκινά από την εύλογη υπόθεση ότι οι ήχοι του περιβάλλοντος (γεωφυσικού, ζωικού, ανθρωπογενούς) αντανakλώνται στη μουσική παραγωγή των ακροατών, η οποία και επηρεάζεται από τις αλλαγές του (Schafer 1994, 103. Schafer 2012, 95). Η συσχέτιση αυτή έχει ήδη σχολιασθεί εκτενώς για την επιρροή π.χ. του τραγουδιού των πουλιών από τις αυγές της μουσικής τέχνης (Schafer 1994, 29. Head 1997, 1 - 23), όπως έχει δείξει η επιστήμη της Ζωομουσικολογίας

(Mâche 1992, 95. Leach 2007, 55). Επίσης έχει συσχετισθεί η επιρροή φυσικών μοτίβων, π.χ. του θαλάσσιου κυματισμού ή κινητικών ρυθμικών μοτίβων π.χ. σε εργατικά τραγούδια (Schafer 1994, 15. Διονυσίου 2020, 119), ή η μίμηση πουλιών σε βυζαντινά Κρατήματα (Apostolopoulos 2024a, 147). Έχει επισημανθεί ακόμα ο παραλληλισμός των «σύντομων εισαγωγικών μοτίβων» στο τραγούδι των πουλιών με τα ψαλτικά σύντομα Απηχήματα (Κουτσογιάννης - Γεωργάκη 2020, 49 - 50), ή ακόμα η επιρροή βιομηχανικών ηχομοτίβων σε σύγχρονες συνθέσεις (Schafer 1994, 108. Τσαφταρίδης 2020, 86). Η επιρροή εκφράζεται στο μουσικό έργο είτε ενσυνείδητα, είτε λόγω ασυνείδητης υποβολής και μάλιστα μετά από μακρόχρονη έκθεση σε συγκεκριμένους ήχους.

Ως γενική παρατήρηση σημειώνεται η συσχέτιση ισόχρονων ακουσμάτων με επικράτηση δισήμων ή τετρασήμων ρυθμών στη ανατολική - θαλασσίνη παράδοση, π.χ. ο κυματισμός, η κωπηλασία ή άλλες μονότονες δράσεις, ή το ομαλό περπάτημα. Από την άλλη, η αντίθεση με τις ανισοχρονίες σε περπάτημα σε κακοτράχαλο έδαφος και με την αισθητοποίηση της μη περιοδικότητας του φυσιώματος του αέρα με αλλαγή έντασης στα κατά περίπτωση φυλλώματα των δέντρων μπορεί να συνδεθεί με την επικράτηση ανισόχρονων ρυθμών και χορών στις ορεινές παραδόσεις (Μπομπωβύ 1984, 34 - 35).

Στο ορεινό αγροτικό περιβάλλον μπορεί να συνδεθεί το μεγάλο ποσοστό αργών – καθιστικών τραγουδιών, καθώς οι βιοτικές δραστηριότητες (π.χ. βόσκηση ζώων) είναι αργές και μακρόσυρτες. Η έλλειψη επίσης άλλων μέσων επικοινωνίας που αναγκάζει τους αγρότες να συνεννοούνται με δυνατές φωνές από ράχη σε ράχη. Ακόμα, η αίσθηση μοναξιάς και απομάκρυνσης σε εργασίες, μακριά από το σπίτι (βοσκή, χωράφι), η οποία απελευθερώνει ψυχολογικά πολλούς να τραγουδήσουν δυνατά, ίσως και πρόθεση επίδειξης και με προσδοκία να ακουστούν, οδηγεί και σε φωνητικό τραγουδιστικό πρότυπο με δυνατή καθαρή και σχετικά υψηλή περιοχή. Η ανάγκη για ένταση σε ομαδικές επιτελέσεις στους υπαίθριους χώρους, αφού δεν υπάρχει ηλεκτρική ενίσχυση του ήχου, οδηγεί σε ομαδικό τραγούδι, όπου βέβαια ξεχωρίζουν οι γυναικείες φωνές, ενώ από όργανα κυριαρχεί η γκάιντα που προσφέρει ικανοποιητική ένταση. Η επιτέλεση επίσης μόνο με φωνές, όταν λείπει μουσικό όργανο, οδηγεί σε υψιφωνίες, σε συνεχή άσκηση και ανάδειξη όσων έχουν δυνατή φωνή. Υπάρχει προσωπική καταγραφή στα Ριζώματα μιας διήγησης κατά την οποία ο θρυλικός Γιαγκούλας (λήσταρχος της περιοχής των αρχών του 20ού αι.) στάθηκε σε απρόσιτη και ασφαλή θέση στο βουνό και άκουγε με θαυμασμό από απόσταση άνω του μισού χιλιομέτρου που τραγουδούσαν άνδρες και γυναίκες σε ένα πασχαλιάτικο χορό.

4.1. Γλώσσα. Ηχοποίηση στο ιδιωματικό τοπικό λεξιλόγιο. Ηχήματα

Πριν από όλα σημειώνεται η επιρροή του ηχοτοπίου στο αρχέγονο μουσικό αντικείμενο, όπως είναι γενικά αποδεκτό, ως κώδικας οργανωμένου ήχου, που είναι αυτή η ίδια η γλώσσα. Είναι κοινώς γνωστό από τη γλωσσολογία ότι τα βόρεια ελληνικά ιδιώματα χαρακτηρίζονται από τις συγκοπές φωνηέντων, την κατά κανόνα αργή χρονική αγωγή στην ομιλία και τις λεγόμενες στενώσεις των «ο» σε «ου» και των «ε» σε «ι». Ήδη τα τελευταία πενήντα χρόνια με την επιβολή της κοινής προφοράς της νεοελληνικής από τα ΜΜΕ, ελέω ηλεκτρισμού, η παλαιά προφορά αλλοιώνεται.

Σταχυολογούνται τριάντα χαρακτηριστικές λέξεις όπου η επιρροή των περιβαλλοντικών ήχων εκφράζεται στις ηχοποιητές λέξεις του τοπικού γλωσσικού ιδιώματος (προσωπική συλλογή λεξιλογίου, βλ. και Δούγα – Τζιτζιλής 2006).

1. *αἷ τιριτι* επιφώνημα σε τραγούδια (Μίμηση οργάνου, όμοιο με βυζαντινά τιριτιρι)
2. *βάζω* (βοώ, κάνω βαβούρα)
3. *Βαρδάρια* (ο θόρυβος του υδροκίνητου αλευρόμυλου)
4. *Γκαπ - γκουπ* (εκδοχή για γαύγισμα)
5. *Γούτο(ς)* (το περιστέρι)
6. *Γρατσανώ* (κάνω γρρρτς)
7. *Καψαλός* (συνειρμός με ήχο καψίματος δέντρου)
8. *Κριτσ'νώ* (κάνω κρρρτς)
9. *Μπάκακας* (βάτραχος)
10. *μπαταριά* (πυροβολισμός)
11. *Ντιρι ντιρ ντιρ* (μίμηση οργάνου σε τραγούδια)
12. *Ντούμπουρ ντούμπουρ ντι* (μίμηση οργάνου σε τραγούδι)
13. *Παταριά* (χτύπημα, μπάτσα)
14. *Παταρνώ* (κάνω πατ)
15. *Πλατσαρνώ* (κάνω πλατς, πλατσουρίζω)

4.2. Ηχοτοπίο και παραδοσιακή μουσική. Ο ρυθμός

Οι επιρροές ρυθμικών προτύπων που υπαγορεύονται από το ηχοτοπίο συμβαίνουν ίσως πιο ασυνείδητα, αλλά έχουν βαθιά επίδραση στη μουσικοποιητική παραγωγή, καθώς ο ρυθμός αποτελεί θεμελιώδες μουσικό συστατικό. Πέρα από τα κοινά ισομερή σχήματα (τετράσημοι) τα οποία ακούει κανείς σε πλήθος ηχητικά πρότυπα (βηματισμός, καρδιακός ρυθμός κ.λπ.) υπάρχουν κυρίως ανισομερείς ρυθμοί, (εξάσημοι, ως 4+2, επτάσημοι 3+4), πολλά αργά ελεύθερα ρυθμοί κομμάτια, αργές αγωγές και αργοί χοροί. Δεκάσημοι με σπάνια εσωτερική δομή και επίσης εντεκάσημοι έχουν καταγραφεί στη Μηλιά Πιερίας (Αποστολόπουλος 2005, tracks 18, 20, 38, 39 και 42). Το είδος *σκάρος* που είναι αυτοσχεδιαστικό ελεύθερου ρυθμού δεν παρατηρείται, αντ' αυτού όμως παίζονται με φλογέρα αργοί καθιστικοί σκοποί, κατά τους οποίους οι πολλές τρίλιες και αυτοσχεδιαστικές φράσεις εξισορροπούν τη μονοτονία των αργών φθόγγων, ώστε να επιτυγχάνεται τελικά το αισθητικό αποτέλεσμα του εντυπωσιασμού (βλ. και Τσαφταρίδης 2020, 89).

4.3. Το μέλος

Παρά τη μεγάλη αναλογία αργών τραγουδιών παρατηρούνται σ' αυτά πολλές τρίλιες και στόλισμα. Υπάρχει η έκφραση: «να το τσακίζει το τραγουδί», δηλαδή να το στολίζει με αναλύσεις και λαρυγγισμούς. Πολλές τρίλιες

επίσης παίζονται στις φλογέρες και στις γκάιντες, θυμίζοντας έντονα κελαηδίσματα και κελαρύσματα από γάργαρο νερό (ακουστικά παραδείγματα 1 και 2). Παρατηρούνται επίσης μιμήσεις ζώων κ.λπ., έρρυθμοι αυτοσχεδιασμοί με πολλαπλές επαναλήψεις ενίοτε πολύ απλών μοτίβων (ακουστικό παράδειγμα 5). Γλιστρήματα φωνής έχουν άμεση σύνδεση με αναστεναγμό ή τη μείωση της ταχύτητας του αέρα στα δέντρα. Σημειώτεον ότι στα ορεινά και απομονωμένα περιβάλλοντα οι περιπτώσεις του θρήνου και του στεναγμού (ξενιτειά, αρρώστιες, απουσία περίθαλψης) ήταν περισσότερες από ό,τι σε αντίστοιχο αστικό περιβάλλον. Πεντάφθογγες κλίμακες, μικρές εκτάσεις, χαρακτηριστικά μικρό ποσοστό τραγουδιών ανατολικού ιδιώματος σε επτάφθογγες κλίμακες και ειδικά διαστηματικά φαινόμενα με φθόγγους σε γλίστρημα μπορούν να συσχετισθούν με το ηχοτοπίο (ακουστικά παραδείγματα 3 και 4). Για παράδειγμα δυσμελώδητα εναρμόνια κατά την αρχαιοελληνική έννοια τετράχορδα που συνδέονται με το γενικότερο σοβαρό ήθος της σχετικής παράδοσης, με το χαρακτηριστικό δίτονο εντός τετραχόρδου και επίσης άλματα με τετάρτες μπορούν να συσχετισθούν με ήχους πουλιών, όπου πολύ σπάνια θα εντοπισθούν ομαλότερες κλίμακες με διαδοχικά τονιαία διαστήματα (ακουστικά παραδείγματα 3 και 4). Οι τετάρτες στήριξης κάτω της τονικής επίσης είναι πολύ βολικές στο παίξιμο τη γκάιντας καθώς βρίσκονται στη βολική θέση τρεις κλειστές οπές κάτω της τονικής η οποία βρίσκεται στη μέση του αυλού (ακουστικά παραδείγματα 2 και 5). Καθοδικά άλματα τρίτης θυμίζουν επίσης τον κούκο (ακουστικό παράδειγμα 4). Μοτίβα δύο ή τριών φθόγγων ισόχρονα επαναλαμβανόμενα σε δευτέρες έως τετάρτες θυμίζουν την παπαδίτσα.

5. Συνοψίζοντας

Οι αλλαγές στο ηχοτοπίο της αγροτικής ελληνικής υπαίθρου, μέρος της οποίας είναι και η μελετώμενη περιοχή, μετά τον εξηλεκτρισμό ήταν σημαντικές. Οι επίδραση στην παραδοσιακή μουσική ήταν αναπόφευκτη. Στοιχεία που ήταν κυρίαρχα και λειτουργούντα για αιώνες και αντανakλούσαν το ηχητικό περιβάλλον που τα γέννησε και τα συντήρησε, παροπλίζονται μπροστά σε άλλα που εμφανίζονται, όχι πάντα καλής ποιότητας και αισθητικής. Μελωδικά και ρυθμικά μοτίβα, κλίμακες, τεχνικές, όργανα, ρεπερτόριο, ακόμα και η ίδια η προφορά και το λεξιλόγιο των τοπικών γλωσσικών ιδιωμάτων χάνονται και σχεδόν καθίστανται μουσειακά είδη. Η καταγραφή και η ανίχνευση της παλαιότερης ηχητικής πραγματικότητας σε ό,τι πρόλαβε να καταστεί αντικείμενο παρατήρησης, μας βοηθά να κατανοήσουμε και να αποτιμήσουμε το θεμελιώδες γεγονός της αλλαγής ιστορικής φάσης που καταγράφεται για τοπικές παραδοσιακές μουσικές.

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Ακουστικά παραδείγματα

1. Καραβασίλης Θύμιος, *Φλογέρα, οργανικό*, αργή διασκευή της «Λαφίνας», Ριζώματα, 0.00' έως 1.10': <https://www.youtube.com/watch?v=kKoNp-xbmoc> Ανακτήθηκε 28/10/2024.
2. Κουτσιούκης Γιάννης, *Τριανταφυλλάκι μ' κόκκιανο...* αργός εξάσημος δρομικός σκοπός γάμου, γκάνιντα, Ριζώματα, 0.57' έως 1.50', <https://www.youtube.com/watch?v=xKG7FjYsLBA> Ανακτήθηκε 28/10/2024.
3. Ημιχόρια σε τραγούδι και χορό από Ελατοχώρι, εξάσημος, *Βουνά μου χαμπηλώσετε*, εναρμόνιο, με ημιχόρια, 0.00' έως 2.51': <https://www.youtube.com/watch?v=vqNVBkHaZzc> Ανακτήθηκε 28/10/2024.
4. Ημιχόρια κατοίκων Ράχης, *Λάλησε κούκε μ' ...* τετράσημος, εναρμόνιο με ημιχόρια, 0.00' έως 1.10', ψηφιακός δίσκος «Τραγούδια Ράχης Πιερίας» track 8, Ράχη Πιερίας, 1998.
5. Κουτσιούκης Γιάννης, *Γκάνιντα, τετράσημος σκοπός* με αυτοσχεδιασμούς, 18.10' έως 23.10': <https://www.youtube.com/watch?v=Qba85G4AIGQ> Ανακτήθηκε 28/10/2024.

Sound Environment and Traditional Music in the Mountainous Pieria before Electrification

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Abstract

The author had the opportunity during the 1960s to experience the sound environment of his native village, Rizomata, located in the mountainous region of Pieria—a region that, more or less, resembled most parts of the mountainous Greek countryside before the advent of electrification. Excluding the sounds of internal combustion engines and the explosions of ammunition, all other sounds originated either from the natural environment or from human activities involving simple tools, with no use of electricity—neither for sound reproduction (radio, phonograph, television) nor amplification (loudspeakers, etc.).

This sound environment, which constituted the acoustic reality for millennia, is naturally reflected in the musical production and the unique musical characteristics of each local tradition. Thus, in addition to the usual sounds of inanimate nature (thunder, wind depending on forest type, water depending on flow characteristics, etc.), this study includes sounds from local fauna (birds, wild and domesticated animals), sounds of specific tools, and, of course, sounds of local musical instruments in use, as well as performance practices—such as large male and female antiphonal choirs in old local musical traditions.

This presentation attempts to document these sound elements and trace influences and parallels with the traditional musical repertoire of the region. In addition to personal experience, comparisons are based on the small discography of the villages in the wider area, which shares common musical traits with the more specific category of Thessalo-Epirote musical tradition. Acoustic ecology indirectly raises the issue of the quality of auditory experiences. Following the vast technological and social changes that have affected even the most remote rural areas, a search for this primordial sound environment—beyond aiding the interpretation of many traditional music phenomena—may help us appreciate a version of "authenticity" in traditional auditory experiences, cleansed of sonic "trash" and poor-quality foreign materials.

Keywords

Soundscape, Pieria, electrification, traditional music

Acoustic Futures: Eavesdropping on Dystopian and Utopian Possibilities

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Abstract

With this article I discuss how acoustic ecology, sound art and studies can contribute to raising awareness by discovering hints of dystopic or utopic future possibilities within the past, as well as the current, acoustic reality. As the arrow of time lets us remember the past but never the future, I argue that we can introduce interdisciplinary research methodologies to investigate in depth and communicate to a wider audience the aural elements of such possible outcomes. Imagined future possibilities are based on collective experience that has accumulated over the years, therefore, the aesthetic materialization that I seek, is a process-based reverse-engineering of an imagined future. By utilizing a variety of practices such as the study of historical artworks of different disciplines and by proposing innovative ways to approaching the soundscape, the article illuminates how sound studies and acoustic ecology may acquire a role that is crucial in envisioning and crafting the future, offering a sensory-rich lens through which we can better understand and possibly influence the trajectories of our world.

Keywords

Future Possibilities, Dystopia, Utopia, Hauntology, Non-cochlear Sound Art, Acoustic Ecology, Phonography, Field Recording, Soundscape, Acoustic Reality

1. Acoustic Futures in Superposition

I am listening to the sound of a drone; an endless insect-like buzz coming from an invisible source changing slightly in pitch as the wind changes direction. It is always present as an inextricable part of the soundscape, acting as the keynote for what is about to follow. Then comes a screeching sound followed by a loud boom and its echo is crossfaded with the rumbling sound of falling debris. A few seconds later it all fades out. What remains is the buzzing of the drone that never left and—as it feels—will never leave this soundscape. This is not an ominous future; it is the very present, being diffused by the loudspeakers in my studio as I am watching a live webcam broadcasting sound and image captured from a rooftop in Gaza the 9th of October 2023. A few years before, I was hiking at a hill in the Golan heights. As I sat down to rest, I listened to birdsong, a slight rustle of the leaves and the distant metallic echoes of cowbells. From a nearby village, I could hear music and laughter, and the world seemed to be doing alright. These two soundscapes are of the same geography and at about the same period.

In this era that is marked by escalating environmental crises, geopolitical tensions, and deepening social inequalities, the need to consider future possibilities has become urgent. Creative practitioners and scholars are increasingly called upon to explore how their disciplines can respond to this discourse. With this article I aim to examine how acoustic ecology, sound studies and sound art can offer insights into the potential trajectories of our world. By engaging with these sonic dimensions, we gain a unique lens through which to reflect on the critical question: What might our future sound like, and how can we influence it? Drawing on Schrödinger's cat thought experiment, I understand the future as existing in a superposition of possibilities—both utopian and dystopian—until observed or realized (Trimmer, 1980). Yet, the arrow of time does allow us to remember the past, but never the future (Hawking, 1988). As a result, we need to come up with alternative ideas of identifying where we stand and where we might be headed. Sound, as an omnipresent element of our environment, has the power to act as both a mirror and a factor for these potential futures. With this writing I explore how sound can shape our

collective understanding of the world to come, focusing on how acoustic ecology and sound studies can help us navigate the uncertainties ahead.

2. Echoes from the future

I am thinking of utopia and I am perplexed. The word, which was introduced by Thomas More in 1516, traditionally refers to an imagined ideal society, often characterized by harmony, equality, and perfection. This vision, however, is not without complexities. By definition the word's etymology derives from the Greek language and means "non-place" (*Definition of UTOPIA*, 2024). Therefore, the condition that the word describes is something that cannot exist. This non-place however can act as "[...] a means of exploring possible futures, rather than necessarily a goal to be achieved" (Levitas, 2013: 141). Thus, utopian thinking serves as a framework for envisioning societal ideals, often highlighting what we find lacking in our current reality, while the perfect world depicted in utopian visions is unreachable, serving more as an aspirational guide than a realizable goal. Conversely, dystopia represents a future where societal ideals are breaking down, often in response to totalitarian governance, environmental degradation, or social inequality. Dystopias act as cautionary tales, focusing on the dangerous outcomes of contemporary trends extrapolated into an ominous future. In *The Dystopian Impulse in Modern Literature*, M. Keith Booker describes dystopia as not merely a vision of an unpleasant future, but a critique of existing social conditions (1994). Dystopian worlds exaggerate current anxieties and fears, making dystopia a magnifying glass through which we highlight and confront our failings. These archetypal narratives are deeply embedded in literature, art, and cinematography. Works like George Orwell's *1984* (2013) illustrate how seemingly positive intentions, like societal order or technological advancement, can lead to oppressive outcomes. In contrast, utopian narratives such as those in Ursula K. Le Guin's *The Dispossessed* (2009) propose alternative social structures that prioritize collective well-being. Utopia and dystopia then, mostly function as idealized endpoints of potential futures, representing hope and fear into their extreme.

When applied to sound, however, it is evident that sounds themselves cannot be inherently utopian or dystopian. Rather, it is through human perception and interpretation that soundscapes acquire meaning. Sound can evoke both familiarity and unease, often depending on the context in which it is experienced and the associations it conjures. In other words, if I paraphrase Maurice Merleau-Ponty's words, it is the investing of the sound by my listening which penetrates and animates it (2002: 308). When it comes to the soundscape, R. Murray Schafer offers a different perspective which highlights that soundscapes shape our emotional and psychological experience of the world. Although he reads them as acoustic arenas in which one hears the societal or natural order of a particular time and place, he also writes that "every soundscape is unique, possessing unique sounds, events, and meanings, which are perceived differently by each listener" (Schafer, 1994: 205). So, even in Schafer's passive approach to the process of listening, understanding soundscapes as potentially utopian or dystopian is not about the sounds themselves, but the frameworks through which they are interpreted. This contextual and perceptual nature of sound lends itself well to examining how soundscapes might reflect notions of utopia or dystopia. For example, a densely layered soundscape of nature sounds might evoke a sense of peace and harmony, whereas a cacophony of industrial noises could signify discomfort or environmental harm. However, as Salomé Voegelin argues, listening "[...] finds itself in the territory of that which is not there as a fact, nor promised as an authoritative truth, but that which is available as a possibility" (2010: 3). So, sound's meaning is fluid and subjective, reliant on the listener's perceptual framework and cultural background. In other words, the same sound could be interpreted as a harbinger of utopia or dystopia depending on the listener's subjective experience and societal context. For example, a solitary bird's song in the ruins of Gaza might signify resilience for some, while for others, it may symbolize isolation and loss.

The interpretive frameworks that shape our perception of utopian and dystopian soundscapes are informed by a long history of archetypes that transcend sound. In visual art, for example, light and harmony often connote utopian ideals, as seen in the pastoral landscapes of Romantic painters. Meanwhile, the fragmented, chaotic compositions of Futurism embody a more dystopian aesthetic, conveying existential unease. These artistic archetypes reflect what Fredric Jameson describes in *Archaeologies of the Future* as an ideological binary between fear and hope. Yet, we need to keep in mind that "utopian and dystopian visions are historical projections, encoding the specific anxieties and aspirations of their times" (Jameson, 2005, p. xii). In sound, these archetypes appear in auditory representations of balance and chaos. For example, balanced rhythms, consistent harmonic structures, and sounds from nature can evoke utopian ideals, echoing tranquility and peace. On the other hand, discordant sounds, abrupt rhythms, and loud, unsettling noises are often associated with dystopian

narratives, mirroring the anxiety of societal collapse. Yet, as Voegelin reminds us, these interpretations are highly subjective: "Sound art does not hold an objective view of the world but insists on a reality that is continually under construction" (2010: 4). This constructivist perspective allows us to consider soundscapes as dynamic, evolving reflections of cultural concerns rather than fixed signifiers of a particular outcome. The perception of soundscapes as utopian or dystopian then hinges on interpretive frameworks shaped by cultural, historical, and psychological factors. Enter acoustic ecology, sound studies and sound art contributing to identifying clues about future possibilities. By examining sound as a socio-cultural element, we can investigate how soundscapes could encapsulate societal fears or aspirations, effectively bridging the gap between the abstract concepts of utopia and dystopia and their potential auditory manifestations.

3. Resounding Realities

As societies evolve, so do their soundscapes, dissimulating not only the auditory by-products of technological and industrial progress but also the anxieties, aspirations, and conflicts inherent in these shifts. Sound then can serve as a medium to reflect upon the cultural, political, and ecological forces that shape our world. Therefore, I argue that in that context, concepts such as acoustic futures and possibilities of utopia or dystopia can be understood not only through visual or literary representations but also through the sounds that shape our perception of the present and our imaginations of the future. At its infancy, the practice of acoustic ecology scrutinized such ideas. For example, R. M. Schaeffer's critique of the noise pollution of industrialization can be seen as a precursor to our current concerns about the sonic impact of climate change and technological saturation. He too argues that soundscapes serve as containing hints for the state of the environment and society, noting that "Modern industrial society is drowning in an overabundance of acoustic information" (Schafer, 1994: 71).

My thoughts though do not start nor end with environmental and ecological concerns or anxieties. There is also a strong link between sound and sociopolitical realities that has already been—and keeps being—studied. Sound through its use, study and interpretation offers insights in societal structures and apprehensions. Acoustic realities and soundscapes embody the social tensions of their environments, becoming a means of both revealing and conserving inequality. Brandon LaBelle argues that "sound operates as a critical resource for thinking about the social" (2010: xix) and consequently navigates boundaries between inclusion and exclusion. Thinking of dystopia, the soundscape is controlled or manipulated to maintain power structures. This may take the form of applying oppressive noise levels in marginalized urban areas or the strategic deployment of sonic weaponry to suppress voices of dissent. On the other hand, utopian acoustic realities promote and welcome inclusivity, community, and shared experiences, challenging hierarchies and creating spaces where the individual can participate in auditory experiences in a framework of equality and solidarity. The soundscape then can become the means of both revealing and perpetuating forms of inequality. As dystopian soundscapes reinforce exclusion and utopian ones promote inclusion, the study of these auditory dynamics reveals much about the social fabric, anointing sound art and sound studies to function as tools to critique and potentially reshape societal boundaries.

Coming back to acoustic ecology it is crucial to explore how natural sounds capture the shifting environmental states that result from human interaction with the planet. Environmental sounds are integral to understanding the health and trajectory of ecosystems: the acoustic presence or absence of certain species, shifts in seasonal soundscapes, and changes in natural sound patterns, all serve as indicators of ecological health. As Douglas Khan notes, "Sound has a special relationship to the environment and to signal production and processing, both in nature and in technical culture" (2013: 2). These factors must be embedded in the investigation of the present conditions as they may surface hints of possible future trajectories. What is significant here is the fact that notions of noise, technological artefacts and silence could be signifying both possibilities. For example, silence or quiet in a utopian perspective could signify a reharmonizing of the human/non-human interaction that would encapsulate a utopic daydream. On the other hand, "[s]ilencing the environment is not only an acoustic phenomenon but an ecological signal of loss" (Kahn, 2013: 20), a dystopic scenario.

The arrow of time always points to the direction of the future. The arrow's irreversibility may not allow us to know what is to come, but we do remember what has already been lost. As Mark Fisher suggests, modern culture is haunted by the slow cancellation of the future (2014). This means that past visions of utopian possibilities have failed to materialize, leaving only traces or ghosts of these futures within our present. What I suggest is that this is reflected in our present soundscapes. Therefore, dystopian future acoustic realities are not only defined by a sinister dissonance but also by the absence of the opposite. Fisher's idea implies that the sounds of our present,

in their repetition or emptiness, reflect a cultural inability to imagine new futures, reinforcing a sense of lost possibilities. By identifying these traces of loss within today's soundscapes, I argue that they can act as a compass to sound artists and scholars that points to the direction in which society's current lost futures lay and possibly to the ways in which society's imaginative stagnation may be reversed through creative interventions.

4. Reverse-Engineering the Future

Having defined the theoretical framework within which such an investigation evolves, I propose a methodology for interpreting and identifying hints of possible utopian or dystopian futures within past and present soundscapes. This methodology adopts an interdisciplinary approach grounded in sound studies, acoustic ecology, and non-cochlear sound art seeking to reveal how social, environmental, and cultural undercurrents are embedded within sonic environments. This primary toolset includes phenomenological listening and capturing, historical contextualization, and analysis of artistic practices, with a particular emphasis on works that engage with the past to shed light on possible futures. To begin, our approach diverges from reduced listening, where sounds are stripped of meaning to emphasize their sonorous qualities alone (Chion, 1994: 2). Instead, it aligns more closely with the concept of non-cochlear sound art, which treats sound as inherently entangled with context, history, and semiotic dimensions. According to Seth Kim-Cohen, "[n]on-cochlear sound art sees sound as an emissary of social and cultural meaning" (2009: 78). Thus, rather than isolating sounds as pure sonic phenomena, this method acknowledges them as situated within socio-political and environmental contexts that carry implications for understanding future possibilities.

The present used to be a past's future. So, the first step comes to listening and interpreting the present through the past. In this way we may come to understand how things evolve, and we might gain useful insights on the trajectories that lie ahead by observing the course of things that have already come to be. Therefore, an essential component of this methodology is historical listening; a technique that draws on Douglas Kahn's realization that historical listening allows us to construct a timeline of changes in the ways we interpret sounds of the environment (2013: 143). This temporal approach to listening interprets past soundscapes not as static artifacts but as indicators of shifting cultural values and ecological conditions. By utilizing historical listening, I aim to uncover both the origins of current soundscapes and the societal and environmental trends that could shape future realities. This coincides with Mark Fisher's concept of hauntology which is instrumental in my analysis, as it provides a framework for understanding how sounds can evoke futures that were forecasted but never realized. Hauntology enables us to identify traces of such lost futures within acoustic reality, particularly when they evoke nostalgia or the eerie presence of what could have been. In that context, sound serves as a repository for these lost futures, evoked through absence or persistent echoes of past ideals.

A major aspect of the proposed methodology is the approach of the present acoustic reality as a source of hints to dystopian or utopian future possibilities. Such a practice incorporates a phenomenological approach to listening, recognizing the importance of subjective auditory experiences and perceptual filters. By drawing on phenomenology, my approach treats listening as an extrovert gesture of expression and sound as an experiential medium through which we interpret place, space, and temporality. Emily Thompson's perspective that "soundscapes are never stable; they are constantly evolving, shaped by changes in the environment, technology, and society" (2004: 2), underscores the fluid and dynamic nature of sonic environments. A phenomenological lens, therefore, allows us to consider how individuals and communities subjectively perceive these shifting soundscapes, especially in response to changes driven by technological, ecological, or socio-political factors.

There are several tools that can help us speculate about future possibilities and consequently create the phenomenological and contextual framework for conducting the reverse-engineering process I propose. Literature has described over the years a variety of potential futures whether dystopian or utopian. Such imaginative works can act as a pool of data ready to be harvested and then reverse-engineered, providing clues of what to listen for in our current acoustic reality. For example, on the utopian perspective, in Ursula Le Guin's *The Dispossessed* we find the following passage:

The silence was deep, not the silence of absence, but of balance. He stood listening to it, feeling it. The sound of the wind was not lost in it, nor the noise of the leaves blowing along the stones of the footpath; those small sounds belonged there, natural, and the silence accepted them (2009: 126).

Here Le Guin conveys a peaceful, harmonious environment, where natural sounds like the wind and leaves contribute to a deep sense of balance and tranquility. The soundscape is not about overwhelming quiet but about

a sense of unity between sounds and silence, reflecting the utopian ideals. On the dystopian forecast of *Fahrenheit 451* the author describes the following imagined soundscape:

The train radio vomited upon Montag, in retaliation, a great ton-load of music made of tin, copper, silver, chromium, and brass. The people in the train all had the same look on their faces, a look that had nothing to do with music or the track or the miles rushing under the earth. The train hissed to its stop (Bradbury, 2012: 75).

In contrast, in this passage the soundscape is one of harsh, metallic noise, symbolizing the dehumanized, industrialized nature of society. The sounds are aggressive and invasive, echoing the oppressive atmosphere of the world Bradbury describes.

Furthermore, I dared to ask artificial intelligence to speculate on acoustic future possibilities:

Luc. Can you describe to me in just a few words the soundscape of a possible dystopian future?

AI. A dystopian future soundscape might be dominated by mechanical drones, muted natural sounds, persistent hums of industrial activity, sporadic bursts of harsh alarms, and a profound silence where vibrant biodiversity once thrived. Human voices, if present, are faint, distorted, or overwhelmed by the relentless background noise of technological systems, creating a sense of isolation and desolation.

Luc. Can you describe to me in just a few words the soundscape of a possible utopian future?

AI. A utopian future soundscape would blend gentle, harmonious natural sounds—like birdsong, flowing water, and rustling leaves—with soft, unobtrusive technological tones. Human voices are clear, warm, and often shared in communal spaces, and the environment feels open and balanced, with peaceful intervals of silence that invite reflection. The sounds of nature and human activity coexist seamlessly, creating a sense of connection, vitality, and tranquility (OpenAI, 2024).

As we can observe even artificial intelligence while trying to describe a utopian or a dystopian possible future acoustic reality, describes it through a perceptual framework and a non-cochlear approach, prioritizing meaning and context over the essence of sound, yet without disregarding it. While my methodology as described before is based on non-cochlear principles, it also incorporates elements of reduced listening where applicable. For instance, by isolating and analyzing specific sonic textures or patterns—such as the mechanical hum of industrial sounds or the absence of natural sound sources—we can examine how these elements contribute to dystopian or utopian soundscapes. This hybrid approach allows for a nuanced interpretation that explores and utilizes the material qualities of sound while acknowledging their cultural and ecological contexts.

5. The Haunting of the Present

Peter Cusack went to dangerous places and started recording. His work is an accurate example reflecting on the methodology I propose, particularly regarding the non-cochlear, phenomenological framework. This is achieved by recording sounds in ecologically and politically charged sites, capturing not only environmental noises but also the specific context that assigns meaning to each recorded document. An excellent example of how the art of field recording can produce a narrative to encode the lingering presence of a dystopic element within a contemporary acoustic reality is *Cuckoo by Radiometer* (Cusack, 2012). The piece features the call of a cuckoo interwoven with the beeps of a radiometer used on site. He captures a soundscape where the beauty of nature contrasts sharply with the underlying reminder of nuclear disaster. Here, the radiometer becomes more than a sound; it's an indicator of a dystopian legacy, where sound transcends its literal qualities to signify historical trauma and future ecological uncertainty. Even though Cusack's purpose was not to reverse-engineer an imagined possible future, unintentionally he transforms sound capture into a performance and a statement, articulating not just what we hear but what these sounds signify, evoking a speculative future marked by environmental fragility and caution. Field recording in this context is not merely about documenting existing soundscapes but becomes a practice of sonic archeology; a methodology to record traces of potential futures already present in today's environment. By listening attentively and capturing these traces, artists and researchers construct a temporal bridge between current realities and speculative futures. Field recording,

especially through an approach informed by acoustic ecology, enables us to identify sound objects that may carry embedded narratives of ecological or sociopolitical significance, helping to understand future dystopian or utopian trajectories.

Within such context sound operates beyond mere auditory perception. As Seth Kim-Cohen posits, non-cochlear sound art invites us to consider not just the sound itself, but the conditions, contexts, and associations it evokes. By utilizing schizophonia, artists can place utopian or dystopian sound objects within accessible spaces and challenge the public to re-imagine familiar surroundings through an altered auditory lens. In doing so, sound art operates as a communicative tool, fostering societal awareness of environmental and social concerns. Looking back at LaBelle's approach to sound as a critical resource for thinking about the social, reinforces this perspective, suggesting that sound interventions can instigate public reflection on contemporary issues that shape future realities. As artists experiment with sounds that reflect both utopian and dystopian imaginings, they facilitate a collective consciousness that engages with speculative futures. Through such practices, sound art highlights the potential for new sonic environments to reshape how we conceptualize our trajectory towards desired or feared futures. A strong example of this approach is Janet Cardiff and George Bures Miller's *The Missing Voice: Case Study B* (1999), which uses an audio-guided walk through the streets of London. This work transforms everyday sounds and spaces into a liminal zone where past, present, and imagined futures merge. It allows participants to perceive their surroundings as altered, prompting reflections on what is hidden beneath the city's surface and on how familiar environments might change or take on different meanings through sound. By embedding an alternate auditory layer within a real environment, Cardiff and Miller's piece challenges participants to re-evaluate their everyday auditory reality, thus illustrating how sound art can reframe perception and infuse public spaces with speculative, evocative narratives.

In reflecting on the potential of sound to map and influence future realities, we uncover a haunting quality inherent in speculative acoustic practices. The artworks born from this methodology exist as both an archive and a prophecy, acting as ghosts within our current acoustic reality. They remind us, that "the lost futures of the past are just as real as those that were once anticipated" (Fisher, 2014, p. xx). In embodying these unrealized possibilities, these soundscapes become more than reflections of current conditions; they serve as aural anticipations, urging us to listen not only for what is but for what might yet become. This interplay between recorded present, extracted from a reverse-engineered imagined future, invites listeners to reconsider their surroundings as haunted by what has been and what could be, rendering sound a powerful medium through which to confront and reimagine our trajectory toward both utopian and dystopian possible futures.

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"Oceanic ClimateScapes" : A real - time sonification of aquatic physicochemical climate change data, set on marine soundscapes

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Abstract

In "Oceanic ClimateScapes" the authors argue that creative sonification can be used to enhance understanding and empathy for the ecological changes occurring in aquatic ecosystems. "Oceanic ClimateScapes" theoretically and practically examines the relationship between culture, nature and performance and how these relate to sonification and algorithmic composition with the help of new technologies such as electronics and programming. The performance included the mapping of four physicochemical parameters (pH, salinity, temperature, water level) to corresponding sound transformations applied to real recorded samples of marine soundscapes (sonification), which were sourced from hydrophone recordings in the Hellenic Trench in collaboration with the "Pelagos" Institute. Ultimately, an algorithmic composition/sonification unfolds, with climate data acting as the "conductor" of the piece. Arduino sensors collect data from a water beaker, which are altered by gestural interventions and mapped to sound parameters for real-time interaction. While the sonification of climate data is scientific and deterministic, the incorporation of aesthetic criteria imposes a new layer of meaning onto the original data, as the latter are used to give significance to a musical parameter. In this sense, artistic sonification could be considered a subcategory of algorithmic composition, and the emphasis on aesthetics can strengthen the listeners' connection to the experience. Climate change is primarily anthropogenic in the Capitalocene Epoch, and in an analogy to sound, all these natural soundscapes become distorted and alienated from their original form. By immersing listeners in the sounds of the seas and oceans and how they are distorted through the sonification of changing physicochemical data, the aim is to inspire a sense of responsibility and action for the preservation of these vital ecosystems.

Keywords

soundscape ecology, aquatic soundscapes, physicochemical data, climate crisis, environmental sound art, marine biophony, Arduino sensors, music programming, algorithmic composition, creative sonification, parameter-mapping sonification (PMSon), real-time interaction, DIY electronics, performance

1. Introduction

Ecological disruptions like coral bleaching, ocean acidification, and polar ice melting remain critical issues, alongside deforestation, extreme weather phenomena and species extinction (Barclay, 2019). Historically, the arts have inspired social change, with ecological art emerging in the late 1960s, driven by figures like Joseph Beuys and Agnes Denes (Davidson, 2019). During this period, acoustic ecology also developed, reflecting environmental issues through soundscapes (Bianchi & Manzo, 2016).

Recently, composers and sound artists have engaged with themes like biodiversity loss and climate change, contributing to environmental sound art. This experimental form helps reconnect people with nature, fostering educational and transformative experiences that align with care theories and aim for "more-than-human" coexistence (Castéra, 2023). Abandoning anthropocentrism, ecological art reflects postmodern ideas that nature has its own agency and meaning making, as argued by Weber (2019). Sound art further embodies this egalitarian approach, transcending human boundaries, echoing Cage's belief that sound is universal.

Natural disasters and the distortion of nature's data highlight the critical role of interpreting global information, as many lives, both human and non-human, depend on it. Developing effective languages to communicate this

vast amount of data is of utmost importance, and artists play a significant role in this process. The technique used in this essay is sonification, the interpretation and presentation of data through sound. According to Andrea Polli (2012), unlike physical materials, datasets are representations that can be explored, processed, and transformed, offering unique opportunities for interpretation. Through sonification works, artists have the potential to evoke emotional responses, influencing environmental understanding and subsequent action, which is particularly crucial in addressing global climate change.

While the literature on sonification has grown, challenges persist in developing sounds that are both universally applicable and aesthetically pleasing for human-machine interaction. A key issue is the lack of a unified theoretical framework, along with the limitations posed by human perceptual and cognitive abilities. Researchers advocate for sonifications that are aesthetically appealing while effectively communicating information. Vickers and Hogg (2006) highlight the role of aesthetics in understanding sonification, while Polansky's concept of "manifestation" introduces an artistic approach, emphasizing sound parameter significance over variable accuracy (Salter et al., 2007). Van Ransbeeck (2018) ultimately classifies artistic sonification as a subset of algorithmic composition, treating it as a form of music.

Environmentalism in performance spans diverse theoretical frameworks, from distinctions like Capitalocene/Anthropocene (Haraway, 2015) to ecofeminist approaches linking gender and environmental activism (Butler et al., 2000). In computer music and algorithmic performance, technology's autonomy imagines new forms of life where technology operates independently of human control. The relevance of such works relies on active, attentive listening (Schafer, 1993) and awareness of the underlying algorithms or artificial intelligence that may orchestrate it. As live algorithms and live coding represent the two ends of the spectrum of human-computer interaction during an algorithmic performance, the concept of gesture remains significant throughout this spectrum. Gesture plays a key role in connecting the artist, audience, and technology, fostering kinesthetic empathy and redefining the relationship between art, mobility, and the environment. Ultimately, gesture unites artist, technology, audience and Earth through shared movement (Guzzo, 2023).

"Oceanic ClimateScapes" explores concepts of ecology through the lens of environmental art, acoustic activism, soundscapes, data sonification as a subcategory of algorithmic music, and ultimately performance. By applying various technological, scientific, and artistic fields, the main goal was to create an innovative structure that highlights the effectiveness of sonification in raising climate awareness through the aesthetic means of performance.

Several influential projects have shaped *"Oceanic ClimateScapes"* in its exploration of environmental performance, data sonification, and D.I.Y. systems for real-time sonification, particularly those with a focus on water. Yin's *"Washing the River"* (1995) examines the ritual purification of polluted waters through performance (Yin, 1995), while works like *"Acid Rain"* (2005) and *"Egyptian Chemistry"* (Biemann, 2012) highlight the performativity of chemistry and frame Nature as Culture. *"Listening Underwater"* (2017) employs hydrophones in a performance aimed at raising ecological awareness (Barclay, 2019). Furthermore, projects that sonify physicochemical data, including *"Atmospherics/ Weather Works"* (Polli, 2007), *"N."* (Polli & Gilmore, 2007) and *"The Climate Symphony"* (Quinn & Meeker, 2001), have paved the way for this approach. More recent initiatives such as *"WaterViz"* (Rustad et al., 2004-2023) and *"WeatherChimes"* (Woo et al., 2023) emphasize collaborative, in-situ methods that integrate science, technology, and art for educational purposes.

2. "Oceanic ClimateScapes" – A performance for the sonification of climate change in marine waters, based on aquatic soundscapes

"Oceanic ClimateScapes" is a performance that has been realized twice up to the time of writing this essay and consists of specific stages. These stages include the collection and editing of sound samples from marine soundscapes, the process of mapping four climatic parameters to sound transformations, the creation of a ten-minute algorithmic composition — sonification, the construction of a custom D.I.Y. Arduino Nano Sensor system to receive real-time values and send them to a musical programming environment (Max-MSP) and, finally, a twenty-minute performance which incorporates the element of real-time sonification.

2.1. Collection and Isolation of Sounds from Marine Ecosystems – Collaboration with the Pelagos Institute

This work began with collecting environmental sounds from marine ecosystems in the Mediterranean Sea. Sonifying physicochemical changes in marine soundscapes offers a promising way to better understand and

appreciate underwater environments by engaging listeners with an often unexplored acoustic dimension. The sound samples were provided by the *Pelagos Cetacean Research Institute* from hydrophone recordings along the Hellenic Trench, spanning from western Cephalonia to southern Crete. The institute, operating since 1993, has developed significant scientific research on marine mammals and collaborates with universities, research centers, and environmental organizations internationally (Frantzis, n.d.).

The Hellenic Trench is heavily impacted by seismic surveys, oil and gas extraction, and dense shipping traffic. These activities, combined with fisheries and climate change, threaten cetacean populations in the region. Thompson et al. (2023) recommend caution regarding new permits for seismic exploration and hydrocarbon extraction in this biodiverse and vulnerable area.

The recordings include sounds from striped dolphins (*Stenella coeruleoalba*) such as high-frequency whistles, blasts from seismic air guns used in hydrocarbon exploration, and military sonar operations. Additionally, a video recording captured social sounds (codas) of sperm whales (*Physeter macrocephalus*), pulsed taps used for communication.

The raw recordings contained significant noise from vessel engines and wave motion affecting the hydrophones. Light EQ, noise reduction, and other processing were applied to clarify sounds. Selected samples for the composition include dolphin whistles, sperm whale codas, seismic blasts, and ecosystem background sounds.

2.2. Setting up virtual samplers, presets, and mapping climate-related physicochemical data to sound transformations (sonification)

Sonification in this project is primarily based on transformations applied to short-duration sound samples derived from the aforementioned recordings, based on specific physicochemical parameters. These are temperature (°C), pH (the negative logarithm of the concentration of H⁺ cations, which measures the acidity of a solution), salinity (the number of salts present in a volume of water, measured in units of psu, i.e., g/kg), and water level (measured in changes in cm). The above parameters undergo changes due to climate change in all the oceans of the planet and there are recent official data and studies that have quantitatively estimated these changes wherever possible (Garcia-Soto et al., 2021 – Olson et al., 2022). These values were taken as a starting point for sonification. The sonification technique used is parameter mapping (PMSon). Table 1 shows the mappings.

The process of sonification was carried out using Max-MSP, specifically through its capability for Presets, which allow for the storage of a “snapshot” of the transformations that sound samples undergo, depending on the changing parameter. All the sound samples used, which were extracted during the first stage of editing, range from a few seconds to a couple of minutes in length. The changes in the four physicochemical parameters alter specific sound parameters or transform the sound of the sound samples into ways that are analyzed in the following subsections according to each physicochemical parameter. The aim is to create an algorithmic composition based on sonification, or in other words, a temporally organized sonification with the help of musical programming in Max-MSP.

Mapping Physicochemical Parameters to Sound Transformations		
#	Physicochemical Parameter	Sound Variable
1.	pH (↓8.2 - 7.7 pH)	speed, pitch shift
2.	Temperature (↑15 - 20 °C)	reverb
3.	Ocean Salinity (↑20 - 50 g/kg)	fm modulator
4.	GMSL (Mean Level) (↑0 - 6 cm)	Matrix

Table 1. Overall mapping of physicochemical parameters to sound transformations

2.2.1. pH

Changes in pH alter the sound samples of *Stenella coeruleoalba*, *Physeter macrocephalus*, and the background sound of the underwater soundscape. The pH varies from 8.2 to 7.7 across five distinct values, which corresponds

to five presets for the aforementioned sound samples. The changes in these samples occur in terms of pitch and playback speed, as detailed in Table 2.

Mapping of pH to pitch and playback speed.			
#	pH (↓8.2 - 7.7)	Sample play speed	Sample pitch shift (semitones)
1.	8,2	1	0
2.	8,07	0,5	-2
3.	7,95	0,31	-5
4.	7,83	2	+6
5.	7,7	-6	-2

Table 2. Mapping of pH to pitch and playback speed

2.2.2. Temperature

Temperature changes were used here to modify the reverb applied to the Matrix. Reverb parameters, such as size, decay-time, high-frequency damping and diffusion, alter in response to rising temperatures, as illustrated in Fig. 1.

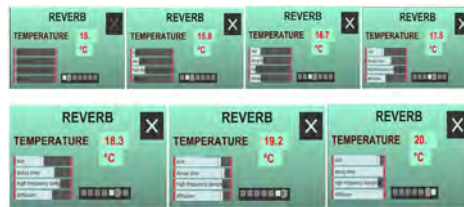


Figure 1. Presets showing Reverbs' characteristics alteration as the temperature rises (15 – 20 °C)

The objective was to shift the composition from the original audio samples in real space to a technically enhanced space with increasing reverberation. This extended decay time "blurs" the start and end of the audio samples, creating a sound that is more expansive and disordered than the original. The presets used here are seven, corresponding to seven temperature values, each ranging from 15 to 20 °C.

2.2.3. Salinity

The sonification of salinity introduces greater complexity, as both the composition and the performance have a temporal dimension. It was therefore deemed useful to introduce salinity as a variable into the system not from the beginning, like the other parameters, but after a certain duration, when salt is effectively added to the system. Until this happens, salinity remains constant at its initial value (20 g/kg) and does not cause any sonic transformation in the system.

When the change begins, it causes alterations in the preset and parameters of an FM modulator that adds sine, triangular, square, or sawtooth waveforms. Additionally, in each preset, both the modulation frequency and modulation index are modified. Like the reverb, the FM modulator is applied to the matrix, thus transforming the overall composition of the individual sound samples. The mappings are shown in Table 3. As the salinity increases, the impact of the FM transformation on the sound samples also increases, with the transformations becoming progressively more intrusive to the original signal.

Mapping of Salinity to Fm Modulator Parameters				
#	Salinity (g/kg)	Fm Modulator Parameters		
		Type of waveform	Mod. Frequency(Hz)	Mod. Index
1.	20	cycle	1	1
2.	27,5	cycle	5	10
3.	35	triangle	20	10
4.	42,5	rectangle	250	1,74
5.	50	sawtooth	250	12

Table 3. Mapping of salinity to FM modulator parameters

2.2.4. Water Level

The Matrix, which is the second to last processor in the patch before the Stereo Out, essentially controls which channels will be played and with what stereo image (see Figure 3). As the water level rises, the density of the orchestration increases, both in terms of the number of sound samples and stereo width. Additionally, the matrix serves the overall purpose of the composition (i.e., the organized sonification over time), which begins with sparse, unprocessed orchestration and evolves into a dense, distorted one. Thus, the composition starts with the playback of just one sound sample and ends with the playback of all four sound samples, heavily layered with effects and distortion.



Figure 2. Matrix Mixer controls which samples play in L-R channels. The “Intervasion” sampler has three outputs

2.2.5. Exclusion of Seismic Airgun Sound Sample from Sonification

In the composition, the seismic airgun sound sample is introduced later, after the sonified transformations of other samples become clear. Unlike other samples, its presets evolve automatically without being linked to specific physicochemical parameters, incorporating microstructural composition and randomness. The sample generates three variations each time, with user-controlled presets adjusting playback-speed and decay (See figure 3). This approach distinguishes the artistic sonification of climate change parameters from the actual sound pollution caused by seismic airguns, which has been shown to disorient cetaceans (Thompson et al., 2023).

2.3. Construction of Arduino PCB circuit – Programming integration with Max-MSP for real-time interaction

To implement the idea of real-time sonification of the physicochemical parameters of water, a microprocessor was required, which, after appropriate programming, could recognize these parameters and their changes with the help of sensors. In the realm of artistic performance, such sensors (like those for pH or ion measurements) are rarely used. However, in the field of D.I.Y. chemical engineering, there are many sensors available for creating such a system, which can be connected electronically with Arduino, Raspberry Pi, and other similar microprocessors. By downloading the corresponding libraries, they can also be programmed accordingly.

A D.I.Y. system like this, with electronic components connected to a specialized PCB (Printed Circuit Board), allows the connection of an Arduino Nano and four sensors, plus a small LED screen. A similar setup is suggested by Engr Fahad on his blog ElectroniClinic.com, where he publishes various guides on the construction and programming of D.I.Y. sensor and microprocessor systems with many applications in engineering, science, technology, and more (Fahad, 2021). This setup of the Arduino electronic circuit and sensors uses four sensors to measure temperature, pH, electrical conductivity/salinity, and water level. To begin, the specialized PCB board was printed (see Fig. 3a) according to the circuit diagram, which outlines all necessary connections and electronic components required (transformers, transistors, capacitors, resistors of various Ohm ratings, headers, etc.) and all components were soldered onto the board (see Fig. 3b). Then, all the necessary sensors were connected (see Fig. 3c). Many of these are in the form of a main board and probe, such as the pH sensor which required

calibration to function correctly. The temperature sensor (DS18B20 Temperature Sensor) is in the form of a probe and requires a 330-ohm resistor between the data and VCC wire for proper function.

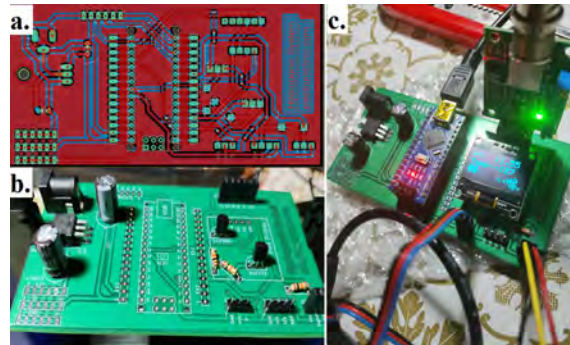


Figure 3. a) printed PCB board according to circuit diagram. b) components soldered onto the board. c) Sensors connected to the board

During the programming phase, it was necessary to download some libraries for the Arduino software to synchronize with the specific sensors and their values. Then, detailed code was written for each sensor, and selections were made regarding how often to record the values and which of them would be displayed on the small LED screen. Some changes were made to the initial code so that the measurements from the four sensors would appear in the Arduino IDE's “Serial Monitor” in the form of a list of four values every 4000 ms. In this format, the lists of values can then be recognized by Max-MSP using a sequence of objects such as `~zl` group, `~itoa`, and `~fromsymbol`, and subsequently separated into distinct values with `~unpack` to signal changes in the presets of the sonification mentioned above, at regular intervals chosen by the user.

2.4. Performance

Once the connection (thru programming) of the input of physicochemical information to the output as sound has been achieved, what remains is the execution by a human performer. After all, human intervention is primarily responsible for the degradation of the oceans, as evidenced by changes in these parameters. The first performance lasted approximately twenty minutes and took place in the enclosed space of Π6 on June 22, 2024, while the second was a bit longer and took place at the On-Off studio on September 29, 2024.

In the practical aspect, an attempt was made to capture the physicochemical data using the four sensors placed in a beaker decorated as an aquarium, implying the presence of a marine ecosystem. The above data changes over time. The chemical parameters (pH and electrical conductivity/salinity) change slowly. During the performance, a bromothymol blue indicator is added. The pH changes as the performer blows into the water through a straw, causing the carbon dioxide from exhalation to dissolve in the water as carbonic acid ions, which ultimately make the pH more acidic. Additionally, vinegar is gradually added, which further decreases the pH. The color of the indicator changes from blue to yellow as the solution becomes more acidic, with drops being added using a pipette. The electrical conductivity begins to change later, around the fourth minute of the performance, when a concentrated saline solution is gradually added using a pipette. The physical parameters (temperature and water level) change autonomously as the ice melts. Figure 4 shows two snapshots from the performance in the Π6 and Ov –Off Studio Spaces.

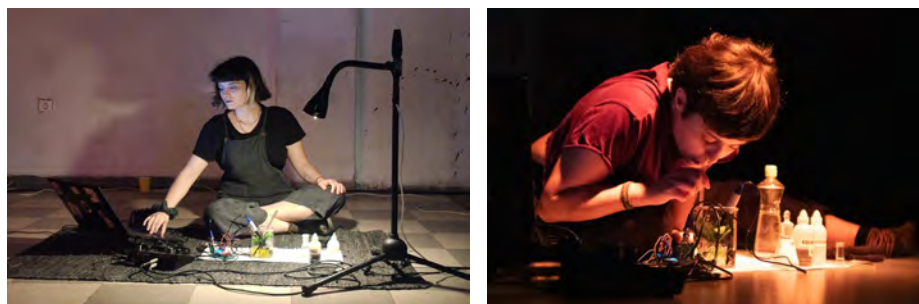


Figure 4. Snapshots from Π6 (left) and Ov-Off studio (right) performances

The live measurement data from the Arduino trigger an algorithmic composition that is based on the preceding sonification, which ultimately reaches the audience's ears through a stereo speaker system. Whenever the performer allows, the environmental data can "play" the transformation of soundscapes, creating an interactive system. The sound samples from sonar guns used for hydrocarbon deposits produce artificial noise pollution, and together with the sonification of the climate, they create a powerful commentary on the challenges facing the oceans.

The performance is divided into two approximately ten-minute segments, each utilizing different forms of interaction. During the first ten minutes, an auto-generated algorithmic process is unfolded based on the sonification data corresponding to parameters (see Chapter 2.2). The data lead the soundscapes from their raw form to a more transformed one, until the sound gradually fades, signaling the second half of the performance. During this time, the performer prepares the beaker of water for the upcoming measurements. In the second half, after pouring the appropriate solutions, with the press of a key, she instructs the system to take real-time measurements, incorporating the element of improvisation into the performance, while continuing to change the parameters with various gestures. The performer controls the real-time process, starting and stopping it at will, enhancing the interaction and enabling creative sonification.

After the end of the two performances, a link was provided to some attendees through which they filled out a feedback form regarding the performance. The texts collected, along with some verbal feedback that was shared after the performances, contributed to the conclusions regarding the impact of the performance on the audience. The feedback form is designed to give attendees the freedom to express their thoughts spontaneously in a small paragraph. The text was answered by approximately 10 people in total.

3. Conclusions

In "Oceanic ClimateScapes", the performance served as the culmination of a multidisciplinary exploration, merging chemistry, electronics, computer science, and sound through artistic sonification with an ecological message. The performance's primary function was to share this sonification with the audience in a live setting, provoking questions about their emotional and intellectual reactions. In many environmental sound art pieces, the in-situ presentation—where the work is showcased in the environment it reflects— plays a crucial role in eliciting emotional responses. However, in this case, a simulated aquatic system was deliberately used instead of the natural marine environment to emphasize the human-induced distortion of marine ecosystems. This distortion was expressed sonically, distinguishing the work from traditional soundscape music. The technological complexity of the project made it impractical to stage the performance in the actual marine location. Despite this, feedback revealed that some viewers found the urban setting a useful contrast, as it helped initiate a process of stress reduction by juxtaposing the performance against the sensory overload of the urban environment.

The work raises the question of whether there is confusion between raw sound pollution and "artificial" distortion through sonification, concluding that both can function for environmental awareness. The sonic transformations, especially during the second half of the performance, do not follow mathematically proportional changes in the physicochemical parameters, as it is creative sonification. The aim was to be realized in the form of a twenty-minute performance, and among its goals is to create a composition with a beginning, middle, and end, during which the system starts from a state of raw sound samples, alongside the unaffected values of the physicochemical parameters, and is gradually led to a state of complete chaos through transformations where it becomes impossible to recognize the original source. This is also related to Schafer's (1993) high and low-fidelity soundscapes, as from the natural high-fidelity marine soundscape, the work ultimately leads, through all the transformations, to an artificial soundscape with very condensed sound information.

Feedback from the "Oceanic ClimateScapes" performance indicates that real-time sonification successfully conveyed the marine environment and its soundscape distortions, with attendees describing the experience as immersive and musically coherent. Some people noted the prominence of seabed sounds and the connection between transformations in sound and chemical changes in the beaker. Gesture also proved significant in understanding the sensory dimensions and facilitating kinesthetic empathy between the artist and the audience. An audience member noted that *"the performance critically highlighted humanity's reckless control over nature, which ultimately suffers under these actions. What began as curiosity soon felt like witnessing an impending catastrophe"*. Suggestions for future work included clearer visualizations depicting the chemical changes that

drive the sound and incorporating more dynamic gestures through movement and impactful chemical reactions, potentially with the involvement of a second performer.

The research concluded that while the sonification of climate data is scientific and deterministic, the incorporation of aesthetic criteria imposes a new additional meaning on the initial meaning of the data, as the latter is used to give significance to a musical parameter. In this sense, artistic sonification could be seen as a subcategory of algorithmic composition, and the aesthetic emphasis can enhance the connection between listeners and the experience. It is evident that the innovative combination of scientific and technological means utilized, achieved the goal of raising awareness about ecological changes in the seas and oceans due to the climate crisis. The "Oceanic ClimateScapes" system resembles the logic of NIME (New Interfaces for Musical Expression), which uses advanced sensors to enhance interaction and create new musical instruments. However, there is also a strong emphasis on mapping, which is temporally sensitive, evolving, and adapting to the context, aiding in aesthetic expression. Though the initial data was multifactorial, and the sonification was complex, as it involved four data points mapped live to sound changes over another four sound samples, the message of ecological changes was well understood by the audience. The combination of auto-generated processes and real-time interaction with a clear demarcation between the two during the performance seems to have contributed to facilitating the performance on one hand and to a better understanding of the sonification on the other. This was supported by the possibilities of personalized programming and direct interaction between the electronic (Arduino) and musical (Max – MSP) software, the emphasis on the aesthetic result during the composition and performance of the algorithmic music/sonification, and the active involvement of the spectators/auditors with their acoustic environment.

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Utilizing soundscape analysis for site-related fixed media composition inspired by the acoustic environment and history of the Decauville route at Alona, Florina

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Abstract

This study investigates the potential of mixed-media music composition in creating site-related music that integrates soundscapes, instrumental music, and electronic sounds. The proposed approach explores how mixed-media music composition can enhance our awareness of the environment and its social context. The research methodology in this study primarily employs qualitative soundscape analysis methods through a case study, resulting in the creation of an original soundscape composition. The focus is on how compositions can reflect the unique qualities of a particular environment and on the compositional techniques that can be developed to integrate these media systematically and methodically.

It centers on two designated sites in the Florina area, in northern Greece: the wind-energy park located at Golina Hill and the Decauville route at Alona, which inspired the fixed media artwork "Trails," which frames the conceptual soundscape of the fictional location inspired by them. It outlines the on-site methodology of the specific soundscape analysis, while assorted recordings, two sound maps, and a comprehensive sound diary are also available. Additionally, this study delves into the processing of those recordings and presents an analytical overview of the compositional process.

Keywords

Soundscape analysis, soundscape synthesis, site-related soundscape composition, past soundscapes

1. Introduction

On November 18th and 19th, 2023, an exploratory expedition took place in the Florina region. Seven composers and seven artists created artworks inspired by seven specific landmarks. These artworks were exhibited for two months as part of a collective installation at the Archaeological Museum of Florina.

This study examines the application of soundscape analysis in creating a *site-related* fixed-media artwork. The term *site-related* refers to works that draw conceptual, emotional, or experiential inspiration from a specific location, yet are not bound to be presented or experienced in that place. Such an artwork reflects or responds to particular aspects of a site—its atmosphere, memory, sound, geography, or personal significance—without being physically tied to it. In this case, the composition is developed through comprehensive sonic, visual, and sensory observations along two distinct trails: the wind-energy park at Golina Peak and the historical Decauville site at Alona. By emphasizing the interconnectedness of auditory stimuli with other sensory experiences, the research lays the groundwork for the fixed-media composition *Trails*.

2. Soundscape analysis

Intentionality towards selected events and objects within a situation informs the outcome experience. Analyzing this experience through this lens could offer valuable tools for a compositional approach (Tzedaki, 2014; Kokolakis, 2016). In this chapter, following the presentation of the conceptual framework, a brief account of in situ sound perception will be provided, accompanied by an analysis of the documented recordings and a reflective discussion on the overall auditory experience.

2.1. Conceptual framework

Soundscape analysis focuses on the key components that influence how individuals perceive the sound environment. These include the nature of the soundscape, listener attention dynamics, and modes of auditory experience, each playing a critical role in a comprehensive understanding.

2.1.1. Soundscape

A soundscape, a term introduced by Schafer (1977, p. 7), refers to the contextual perception of an acoustic environment, encompassing natural, artificial, and imagined sound sources within a defined conceptual area, reflecting an expanded understanding beyond Schafer’s original concept. A soundscape can be experienced in situ, from memory, through various forms of documentation, or via a holistic, integrative approach that combines these methods.

2.1.2. Attention zone

The term *attention zone* refers to the stimuli that the observer consciously attends to (Ganchrow, 2015). In contrast, *sonic contact distance* denotes the spatial range around the observer where certain sonic stimuli can interact with the observer's auditory sensors. Several parameters influence the area covered by the observer's attention, including the time available near the sound source, the abundance and type of stimuli present, and the individual's intent toward or focus on the source (Kokolakis, 2016).

2.1.3. Ways of Listening

Various approaches exist for understanding and categorizing the different modes of experiencing sonic stimuli (Kane, 2007; Smalley, 1996). These approaches often reflect the nuances and perspectives through which each author perceives sound. The auditory modes referenced in this study, such as multimodal auditory experience, sound as a carrier of meaning, sound connected with its source, sound as morphology, a holistic view of sound, and interplay, are presented in Kokolakis (2016).

2.1.4. Perceptual evolution

Perception is inherently subjective, shaped by individual sensory modalities and cognitive processes. It evolves as we engage with and reinterpret our specific experiences over time. In this context, creation represents a balance between the past and the future. Consequently, how we approach and perceive an experience directly influences how it will be projected into the future. Developing various methods to engage with these experiences is essential to the compositional process and its significance to the artistic output.

2.2. On-site

The two-day immersive experience provided me with a comprehensive perspective on the physical, conceptual, and imagined interconnections among various locations, leading to a cohesive and integrated understanding. Alongside the hydrological pathways that connected these sites, the distinctive acoustic ecologies of each place enriched the cumulative conceptual soundscape, broadening the perspective of the overall encounter.

2.2.1. Location 1: Varnoundas, Golina Peak, wind energy park – Florina

“Our inaugural destination was the wind-energy park situated atop Golina Peak in Varnoundas mountain, facing the Vigla Pisoderio ski resort of Florina. Commencing our journey from above Vigla's parking lot, where a small structure was situated and sparse biological sounds could be observed, we traversed the path leading to Golina Peak, home to 34 wind turbines. Despite the sunny day, the snow had just fallen, accompanied by a moderate wind that occasionally sent thin cascades pushing ice down from the treetops with sudden gusts.

The soundscape primarily comprised geophysical sounds intertwined with the human-made sounds of our group of 12 people. As we ascended the mountain, the mechanical sounds in the background, emanating from the paved road next to the parking lot, gradually faded away, and the sound of the wind turbines steadily asserted its presence, becoming increasingly imposing as we drew closer."

2.2.2. Location 2: Alona, Decauville route – Florina

"The following day, I visited Alona, one of the final stops along the historical Decauville French train route constructed by the French during WWI, initially for military purposes. It was designed to be easily assembled and highly portable, making it suitable for rapid deployment by experienced soldiers. The little train had its starting point at Armenochori (Mesonisi) Train Station. At the beginning of 1917, it operated three routes: one to Marina village, another to Perasma village, and a third to Florina and Alona.

Nowadays, only the stone remnants of this structure remain, frozen in time, prompting reflection on the place's past life amidst the immersive natural soundscape surrounding it. The river's delicate yet assertive rush defines the present-day winter soundscape near the structure, gradually fading into the background as one ventures into the forest, making space for the natural and mechanical sounds of the place's daily life.

The soundwalk and recording sessions at Alona were conducted on the morning of Saturday, November 19th, following the previous afternoon's snowfall we experienced at Varnoundas. It was a sunny day, accompanied by a lingering scent of humidity. The sky was remarkably clear and blue despite the previous day's weather conditions, and the temperature was bearable at around 10 degrees Celsius. Over time, the humidity faded, along with the awakening of natural life and the start of residents' daily agricultural tasks and other routines.

Walking alongside the riverbank, I immersed myself in a meditative state, listening attentively to the ever-changing sounds of the flowing water. I imagined the melting snow I had witnessed the previous day at Varnoundas merging with the current, intensifying its compelling pull and creating a comfortable isolated space within the percussive water sound. However, this lively space swiftly and gently receded into the background as I traversed the elevated opposite bank, giving its place to the serene tranquility of the forest, accompanied by the sparse winter wildlife sounds of birds, insects, and boars, the gusts of wind through the trees, the far-away talks, and human-made mechanical hum of cars and tractors in the fields and the asphalt road running parallel to the river. The distant echoes of a nearby wood processing workshop, with its sporadic sounds of saws and axes, resonated stoically throughout the amphitheatrical valley, adding a unique color to the overall morning soundscape painting."

2.3. Field recordings

The two-day recording session took place at two locations, each lasting approximately three hours. Through those recordings, I aimed to capture the unique qualities of locations and auditory occurrences that were intuitively interesting morphologically or contextually and left an imprint in my consciousness after a preliminary on-site observation, such as keynote sounds, characteristic sound instances, sounds with interesting rhythmic and gestural properties, and sound signals.

The audio recording method involved prolonged, continuous recordings to capture extended sound instances, an overall soundscape perspective, or shorter, focused sessions aimed at specific, shorter sound instances. The recording setups utilized a handheld recorder (ZOOM H4n) configured in four different arrangements, including built-in stereo microphones and connections for a hydrophone (H1a), geophone (LOM Geofón), or shotgun microphone (Sennheiser) for mono or stereo recordings.

2.3.1. Keynote sounds

The river recordings near the stone structure at Alona were conducted using a handheld recorder with either built-in stereo microphones or a submerged hydrophone positioned close to or inside the water at various flow points. The hydrophone captured the depth of low frequencies and distinct percussive sounds in the mid-high register, while the built-in microphones picked up subtleties in the mid-to-high range and blended the river's flow with surrounding ambient sounds.

Approaching the wind-energy park at Golina Peak, the periodic sound of the wind turbines gradually became more dominant. This process was captured from a distance using a shotgun microphone. Additionally, the mechanical periodic noise of the turbines, caused by wind gusts and punctuated by masses of partly melted ice of various sizes falling on the metallic structure, was recorded using a geophone attached to the turbine's hollow column via a designated magnet, which captured the sound reflections within its walls.

2.3.2. Other sound elements

The fresh snow began to melt under the sunny weather, allowing several recordings to center around this theme. A hydrophone, carefully placed under small streams or on leaves beneath the flowing water, captured the sound of the melting snow's water flow. On one occasion, the hydrophone was inserted into the snow next to the water flow, allowing for the documentation of the gradual melting of the snow. Compared to the water flows recorded at Alona, those in Varnoundas were less immersive, offering a more detailed and intimate sound. On the other hand, the recording of ice falling onto leaves during the return trip was highly immersive, creating the sensation of being surrounded by a continuously evolving entity driven by gusts of wind.

Ambient woodland sounds complemented the wooden landscape in the forest near the Decauville relics at Alona. The amphitheatrical valley's resonances created a sense of spaciousness, contrasting the densely packed forest's smaller spaces. Two extended recording sessions focused on capturing ambient sounds from a distant woodcutting workshop featuring axe and saw activity, recorded with a shotgun microphone. Additional wooden and environmental sounds, such as knocking on wood and walking on dry leaves, were captured with the handheld recorder's built-in stereo microphones.

On my way back from Golina Peak, near the parking area by the mountain path's entrance, I encountered a frightened dog wearing a collar but without any human presence nearby, even though a café was across the street. The collar had a goat bell, producing a distinctive sound with each movement. As I cautiously approached, the dog kept its distance, creating a slow, distanced dance between us, which I captured briefly with a handheld recorder. This surreal, minor encounter lingered in my thoughts, with a sense of quiet urgency, throughout my journey around Florina and during the composition of *Trails*.

While walking through the wind-energy park at Golina Peak, I noticed an indeterminate, mechanical sonic signal from afar, with a fundamental frequency oscillating between 1000 and 1500 Hz. This sound appeared periodically, about every 15 minutes, lasting only a few seconds each time. Unable to record it initially, I finally captured it on my return amidst shifting wind gusts using my handheld recorder. Later discussions with local colleagues were needed to provide definitive answers regarding its source, leaving the sound's origin a mystery.

2.4. Reflection and integrative perspectives of sonic characteristics

Reflection is a core aspect of the compositional process, making the development of various approaches to engaging with related past experiences essential for the creative endeavor and its outcomes. A temporal and qualitative method was used to reflect on the materials of *Trails*.

In the initial stage, on-site observations and preliminary analyses were conducted, resulting in the identification of critical points for further examination. These points were documented through notes and audio recordings. Shortly afterward, a broader framework was conceptualized from memory and documented in a concise essay, capturing an overview of the experience. Combined with the on-site notes and recordings, it was the closest reference point for the initial experience.

Furthermore, it established a framework for subsequent documentation analyses, offering an alternative observational perspective. The observations from the documentation differ from those made on-site in terms of temporal, contextual, and media aspects. Observations through documentation allowed for variations in sequences, durations, physical surroundings, and circumstances, all conveyed through multiple media formats that imprinted their distinct signatures on the resultant experience. The on-site observations and those derived from the documentation established a basis for understanding the experience as an unfragmented object (Roads, 2001, pp. 3-7; Kokolakis, 2016), contributing to the development of the compositional process for *Trails*.

2.4.1. Rhythmic characteristics

The rhythmic characteristics of the observed sounds spanned a broad spectrum. At one end were the random but frequent peaks from various water flows, creating dense and irregular rhythmic textures. These contrasted with the occasional effect of gusts of wind, which caused melting ice to fall onto dry leaves, as well as the periodic, punctuated echoes of ice reverberating within the columns of wind turbines. Distinct rhythmic patterns emerged from the resonant sounds of the woodcutting workshop, amplified as they reverberated across the amphitheatrical valley alongside deliberate, structured gestures produced by knocking on wood. These elements formed a complex rhythmic landscape, ranging from natural randomness to intentional patterning.

2.4.2. Spectral characteristics

The spectral characteristics of the observed sounds can be arranged along a spectrum from more complex to less complex tonal qualities. The wind turbines generated a dense, low-frequency noise with a chaotic structure and indistinct harmonic definitions. Similarly, the melting ice falling on dry leaves produced a noise quality that was less dense and more expanded. The flowing water created an expansive sound characterized by a diffuse texture and subtle tonal variations. The glissando of the saw introduced a sliding pitch within a noise quality in the middle-low register. In contrast, the pronounced wood sounds exhibited more explicit tonal definitions in the middle-high register, featuring distinct pitches, and the bell contributed resonant tones marked by inharmonic overtones. The unidentified sound from far away represented the least complex element, distinguished by its clear pitch as a singular tonal component within the overall soundscape.

2.4.3. Spatial characteristics

Sound can be perceived spatially in diverse ways (Smalley, 2007; Ganchrow, 2015; Ganchrow, 2012; Kokolakis, 2016). This section examines the physical breadth of various sound environments, ordered from more to less reverberant. In the amphitheatrical valley, certain sounds, like those from the woodcutting saw, carried significant echoes, allowing them to travel across the valley and define its expansive spatiality. The falling masses of melting snow struck the metal inside the wind turbine column, creating an amplified, echoic quality that emphasized the column's resonant space. Alternatively, the high-pitched, unidentified, distant sound highlighted a sense of vast distance. The sound of melting ice landing on dry leaves within the forest provided a sense of the layered distances between the trees. Conversely, the water sounds near the stream formed an intimate, enveloping auditory space, isolating the listener from the broader environment. The sounds captured deep within the woods defined a secluded, intimate auditory space, emphasizing isolation and proximity.

2.4.4. Interaction and interpretation

Reflecting on the two-day experience across both sites revealed sonic events that have stayed vividly in my memory, each embodying a unique essence as distinct *sound objects* of various temporal dimensions (Roads, 2001, pp. 3-7; Kokolakis, 2016). These *sound objects* can be interpreted within conceptual classifications, such as the directionality and resolution of hydrological pathways transitioning from snow to flowing water, the inevitable periodicity of the wind turbines and the varied levels of intentionality present in various biological sounds – from the enigmatic biological presence suggested by the wandering dog to the human engagement evident in the gestural sounds of the woodcutting workshop, and the rhythmic patterning of deliberate wood knocks. The unidentified sound at Golina Peak served as an unorthodox carrier of meaning, raising an unanswered question about its origin and significance.

Both sensory and contextual contrasts played a critical role in deepening the experience. Standing in silence, Alona's Decauville stone remnants embodied a past intertwined with natural evolution. At the same time, the towering turbines at Golina Peak presented a stark juxtaposition of human engineering against the backdrop of nature. With its expansive scale, the amphitheatrical valley of Alona functioned as a natural stage for pivotal historical events that unfolded in recent history, and the dense, humid forest near the river enveloped one in a tactile, almost hidden complexity.

The trails in Varnoundas and Alona exhibited a series of distinct contextual contrasts: snow versus water flow, high-altitude mountain paths versus low-lying valley routes, functional structures versus remnants, human dominance over nature versus nature's reclamation over human presence, entering a mechanical sound-

dominated conceptual space versus exiting it, present versus past, and speculation for the future versus historical conclusions, providing a sharp metaphor of the seemingly liminal situation in the area and a valuable foundation for the development of the composition *Trails*.

3. Instrumental perspective and the sound sources

An *instrument* is a crafted or repurposed object made from available materials, designed or modified to produce sounds that exhibit specific tonal, rhythmic, dynamic, or textural qualities in musical or performative contexts. In this framework, a soundscape—or specific sounds within it—can be adapted through physical, virtual, or even conceptual tools and abstractions (*Stream for Marimba*, Kokolakis, 2016; *The Weight of Heaven*, 2024) towards an instrumental perspective.

3.1. Materiality

The spectral qualities of a sound communicate its materiality, establishing a distinct presence within the sonic environment. The bell's resonant footprint, marked by inharmonic overtones, conveys a metallic and expansive texture, while wood sounds, with their more pronounced tonal profile in the middle and high registers, reflect a solid, organic quality. Similarly, dry leaves' brittle, noise-rich profile evokes a sense of fragility. These unique spectral signatures enable the perceptual recognition of each material's properties within the broader soundscape.

3.2. Space

Spatial qualities such as reverberance, distance, and presence—or the perceptual volume of a sound—are some parameters that help define a sound object's space (Kokolakis, 2016). These qualities tie spatial perception to acoustic properties, with each environment creating a unique auditory signature. From the expansive echo of open spaces to the intimate closeness of nearby sounds in isolation, they reveal both the physical and perceptual boundaries of soundscapes, offering composers tools to shape the listener's perceptions of proximity, depth, and space.

3.3. Gesture

In *Trails*, the rhythmic qualities of recorded sounds served as foundational gestural materials shaped through varied compositional techniques. Subtle equalization highlighted specific frequency ranges in sounds like melting ice on dry leaves, turbine echoes, and wood knocking. Additionally, independent of the field recordings, electronic sounds were convoluted with them, utilizing the rhythmic qualities of water flows, wind-driven ice, and woodcutting echoes to create complex textures or distinct patterns. Layering and overlapping further enriched these gestures, aligning with the piece's conceptual framework.

4. Composition

Engaging with and analyzing an experience provides valuable tools for a site-related compositional approach. Reflection is a fundamental aspect of the compositional process. Besides their conceptual value, the observations made on-site or during the reflection process provide the physical and virtual materials derived from the sound sources via the recordings and their processing, which could be valuable for their instrumental quality.

4.1. Concept

The experience in Florina left me with an open question, leading to a non-conclusive approach in composing *Trails*. Much like the sonic environment in a natural setting, which gains significance through the act of listening and interpretation, I chose to incorporate key elements from my observations, allowing space for the listener to engage with the artwork in their own way, thereby creating a dialogue between the listener and the piece. By foregrounding the organic qualities of the sound sources alongside my compositional insights, I aimed to foster

an immersive experience that transcends a singular narrative, encouraging each listener to engage with the composition through personal interpretation.

The sound of the bell, the image of the frightened dog in the snowy landscape, the distant voices, and the "dance" between us formed a profoundly impactful experience that remained vivid throughout my journey. It appeared that this beautiful area, much like the creature, was anticipating a significant shift forward, drawing valuable lessons from its history and raising awareness about its unique natural beauty, resources, and environmental needs, as well as its strategic location and the potential of its human resources.

I imagined the listener amidst the enduring stone remnants of the Decauville structure, frozen in time, where an immersive soundscape unfolded, weaving tales that resonate from the past and the future. As the haunting echoes fill the space, a lone bell tolls from the collar of a wandering dog, prompting contemplation on the enigmatic figure it anticipates, evoking the essence of an awaited Ulysses.

The contextual contrasts of this integrated experience formed the basic structural materials during the compositional process.

4.2. Structure

The composition is structured into three primary layers. At its core lies an intrinsic process comprising two field recordings that persist throughout the piece. These recordings, emphasizing sound morphology, emulate the transition from snow to water, encompassing the auditory experiences of ice descending on leaves at Varnoundas and the meandering waters of Alona while also capturing the smaller water flows generated by melting snow at Golina Peak.

In contrast to the fluidity inherent in these sounds, the punctuated, percussive deep tones produced by melting masses of snow, as captured with the geophone, are strategically integrated throughout the composition. As markers for pivotal junctures within the musical narrative, these elements also evoke a tangible sense of inevitability.

The second layer of the composition accentuates the rhythmic and gestural characteristics of the original field recordings while simultaneously establishing a harmonic background for the piece. This layer, constructed using virtual instruments and a structured improvisation performed on a MIDI controller, alternates between two distinct sonic elements, harmonically creating variations in shading and contrast within the composition.

Firstly, the melting snow water flow at Golina Peak transforms into an ever-changing chord, alternating between D, G, A, and B, creating a dense, embracing atmosphere of beatings and blending. This chord fluctuates throughout the piece, establishing a fundamental tonal framework centered around G.

Secondly, the sounds originating from the woodcutting workshop are integrated, transitioning into a chord comprising D, G, A, and F. This element accentuates the higher harmonics present during each saw utilization, crafting a steadfast, stoic ostinato pattern that traverses the auditory space, offering an immersive experience for the listener and implying the human presence within those gestures.

The third layer encompasses significant gestures that integrate the conceptual elements of the composition. The handbell-like sound at the climax, alternating between D, E, F, F#, G, and A, accompanied by the convoluted echoes of the bell in the lower register, functions as an awakening call, where the highest and lowest tonal contexts of the composition coexist. This contrasts with the meticulously placed wood-on-wood human-made sounds in an isolated space, representing the sole deliberate gesture within this more confined temporal frame. Furthermore, the indeterminate high-pitched sound emanating from a distance serves as an eerie reminder of the unknown, delineating the border of the soundscape.

4.3. Presentation

These elements were mixed for a stereo setup, virtually creating the imagined space of the composition. They were designed to be exhibited in the Archaeological Museum of Florina through a headphone arrangement, allowing each audience member to experience it individually. Additionally, the piece is presented online on a designated website. *Trails* was paired during the exhibition with the visual interactive installation *Reminiscence – Anamnesis* by Philippos Kalamaras, which features a 3D interactive process video of the Decauville location at Alona and a 3D print of the site.

5. Epilogue

In this project, I immersed myself in the Florina area, focusing on two primary locations central to my artwork. Conducted within a brief period and without prior familiarity with the region, this exploration naturally adopted the perspective of an exploratory outsider. As a preliminary investigation into this conceptual space, this project lays the foundation for future engagement and expansion upon these initial findings.

I focused on integrating soundscapes, instrumental music, and electronic sounds through an instrumental perspective, aiming to achieve an organic and aesthetically refined result that captures the essence of my overall experience. Drawing on the concept of the *sound object* across varying temporal frames and sonic characteristics, I created a sound collage to invite listeners into a holistic virtual audio experience analogous to my on-site engagement, as crystallized through a detailed soundscape analysis, all encapsulated within a five-minute time limit.

Future directions for this artwork involve a more cohesive integration of the sonic and visual elements, enhancing their multidimensional impact. Developing an interactive composition version could allow audiences to experience it in various ways within a virtual environment, further deepening its immersive and experiential layers.

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Knud Viktor (1924-2013) – The Art of Listening

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Abstract

This article dives into the art of Knud Viktor, a Danish artist who initially trained in The Royal Danish Academy of Fine Arts, and settled in the Luberon (south of France) in the early 60's. After discovering the specificities of the acoustic landscape of the Mediterranean area and the influence of light on cicadas – which varies according to the weather – he took an artistic turn which places interdisciplinarity at the center and where field recording and electroacoustic composing were then a focal point. Knud Viktor became a "sound painter" and endeavored to document the sonorities surrounding him by creating his "sound images" – territorial and abstract works of art. The most famous one is Image VI (or Luberon Symphony). He created his own tools and he also invented ploys to record the inaudible: The Dreaming Rabbit, The Fighting Ants, or the mountain's erosion are a few examples of the particular "macroacoustic" he devised. To this regard, as early as the 70's, the entirety of his recordings bears witness to the biophonic and geophonic vitality of the region and allows to keep traces of acoustic atmospheres at a time endangered by industrialization. Our analysis allows us to grasp how the kind of listening practiced by Viktor – a listening linked to the present; a sort of deep listening applied to the study of sounds from nature – contributes to the construction of a sensibility much needed in present times. We will do so by relying on documents, interviews and notions such as "schizophonia". Thus, this study allows us to pinpoint the aesthetic input to acoustic ecology but also the concrete links maintained by Knud Viktor with this movement.

Keywords

Knud Viktor, field recording, acoustic ecology, "sound painting", sound installation, biophony, geophony, music, deep listening, in situ art, schizophonia

"I heard the tensions before the blooming of the leaves" (Varier): with few words, this sentence pronounced by Knud Viktor crystalizes the depth of listening that this Danish artist deployed for over 50 years by exploring the acoustic worlds of the Petit Luberon, a French region in which he settled in the beginning of the 60's after studying painting and engraving at The Royal Danish Academy of Fine Arts of Copenhagen. His explorations were soon realized in heterogeneous artistic works paired with an acoustic and visual approach. This is why he often called himself a "sound painter", a phrase which re-establishes Viktor's artistic heritage and foregrounds the transversality of a process articulated around the close relationships between image and sound.

1. Beyond musicality: widening one's acoustic sensibility

Becoming able to hear the tensions before the blooming of the leaves is of course to have inherited the lessons of John Cage (and those of Erik Satie before him). They encouraged us to focus all of our attention to every day sounds and to include into music what had been excluded from this field (the non-musical, the non-intentional, the random).

Francis Dhomont, in a speech given at the 7th Spring of Electroacoustic of Montreal in 1992 (6-21 June), said:

The most ingenious invention in acoustic ecology I ever discovered was long ago, in a bistro I often went to, where a juke-box, for the price of one song, would play a song of... silence (sic). Three minutes and thirty seconds of happiness, after what the racket would resume all over again.

This quote from Dhomont who had a serious influence on Viktor's acoustic studies³⁴, interests us since it complexifies the history of acoustic ecology, a discipline whose coming into life happened at the end of the 60's under Schafer's impulse (in Canada) around the creation of the *World Soundscape Project* (WSP).

The Montreal event, organized in 1992 by Claude Schryer, was centered around acoustic ecology and included Knud Viktor amongst other major figures of the movement, such as Raymond Murray Schafer and Hildegard Westerkamp.

Although, naturally this heritage is extremely important to understand the way this discipline emerged and how it spread little by little, it should not overshadow the steps in the history of experimental music since it allowed the elaboration of a type of listening which acoustic ecology demands. It is defined as follows: "a discipline which takes interest in the ecological aspect of sound, that is in the relationships between living beings and their acoustic environments" (Barbanti et al., 2024: 117). The contribution of French composer Pierre Mariétan should also be mentioned, as well as the year 1952 (creation date of Cage's 4'33'') which constitutes an obvious keystone in the environmental history of music and acoustic arts since it marked a paradigm shift in the connection to listening and in what is worthy or not of being listened to.

2. Art as an experience and as an experimental knowledge process

I recorded a spider weaving its web. You have to spend nights and nights before obtaining something usable. [...] But once I know this sound exists, I can hear it. Once you discover the nature of the sound, it is easier to make it out from the background noise. (NightOwl, 2016)

Becoming able to hear the tensions before the blooming of the leaves, like being able to hear this spider patiently weaving its web, that stone vibrating because of the wind, or that worm who moves inside an apple and being able to specify, as Viktor, that "we can really hear the juice of the apple and we have the impression that the worm is enjoying itself" (Martin), being able to perceive the entirety of these little sounds and record them, then elaborate located artistic propositions from the recordings which do not alter what was heard, seen and perceived, is transforming experience into art and practicing art as an experience (Dewey). It is returning the intrinsic attention to the active perception act. It is giving back a moment when the senses were put on the lookout in an amplified way. Also, most of all, it is to commit to an art of observation and listening which nourishes "a process of experimental knowledge" (Barbanti et al., 2024: 36) which we crucially need today to better grasp our environment.

Practicing this art as an experience is inventing forms of sensitive knowledge of the world which put into focus the question of the relationship with the apprehended beings, and it appears to us that it is what Viktor managed to do when he listened, then recorded and filmed, during the summer of 1978, life in a small scops owl nest:

I have a little scops owl near where I live because I let the grass grow between the olive trees. I don't use chemicals and there are big insects who are food for this bird. This is why I was able to study it for years. I wanted to know the secret of this note. There were months of work to get them used to me before starting recording. And little tricks. I spent nights outside on my back lying in wait for them. At first, I slept under a rug to see where in the stones they wanted to nest to be able to put the mike before them. The first time, I put my mikes where they were going to nest. They did not know about it. On the other hand, they knew a lot of things about me. I have recordings of specific sounds made in my presence. I claim it is a sound which applies to me, because I knew where they were, and when other humans came by, it was another reaction. (NightOwl, 2019)

This long naturalist study, both acoustic and photographic (Figure 1) will result in a project of a 7-inch single edited in 2019 (posthumous) by the Danish record label *Institut for Dansk Lydarkæologi*. Simply entitled *The Little Scops Owl*, it includes both the field acoustic recordings and Viktor's voice which comments the behaviors of the animal and thus resembles a sort of ethologic story.

³⁴ Indeed, Francis Dhomont was an extremely important mentor in Knud Viktor's musical training from the beginning of his researches on sound. It was through the intermediary of this composer – close from the *Groupe de Recherches Musicales* (Musical Research Group) and its members – that Knud Viktor will come across the *musique concrète* movement founded by Pierre Schaeffer. An approach from which he clearly distanced himself.



Figure 1

3. Building bridges between *in situ* and *ex situ* listening (schizophonia)

In this specific acoustic project, Viktor's voice appears to be a powerful mean to overcome one of the major difficulties of acoustic ecology which is to *make do* with the deterritorialization inherent to the practice of field recording: it is what Schafer (2010) named “schizophonia”. Inspired by the notion of schizophrenia, schizophonia evokes the difference between direct listening (*in situ*) and the listening of sounds recorded and reproduced in another space of broadcasting (indirect listening or *ex situ*). All field recordings bear the mark of the erosion of their links with the situation in which they were born.

If the acoustic ecology represented by Schafer perceives this dimension as negative and degrading, it is quite the opposite for the practitioners of *musique concrète* (and its leader Pierre Schaeffer) who embraced this characteristic of field recording to be the foundation of the core of *écoute réduite* (or acousmatic listening): “The *écoute réduite* is an attitude of listening which consists of listening to the sound *for itself*, as an *acoustic object* by taking out of the equation its real or supposed origin, and the meaning it can carry” (Chion). Thus, the *écoute réduite* appears to borrow its flesh to the schizophonic model. In this regard, both types of listening (reduced and schizophonic) can partly be mixed up.

When asked what were the ways to overcome this difficulty particular to field recording and to any compositional work (schizophonia), meaning *in fine* the great difficulty (or even impossibility) for the audience to find a link to the place and context of the recording, the composer Hildegard Westerkamp specifies – about Knud Viktor's work and her own artistic practice – that the voice is a genuine tool to build the necessary (and essential) bridge between the capture's space-time and the restitution's one. For Westerkamp, the voice thus allows to construct a bridge between two types of listening, the recorder's one and the listener's one:

I think that as a field recordist and as a composer I have to be very very conscious of the difference between being in a place, listening and recording it, and then for the listener to hear it in completely different contexts. That's why I suspect the voice of Knud Viktor in some of his pieces [e.g., *The Little Scops Owl*] or in my pieces to build a sort of a bridge between the place we're in when we are recording and the place that listeners are in when they are listening to that work. (...) Our listeners have no relationship to the place that we are in relationship to. And that lack of relationship has to be bridged especially when we think ecologically. (Michel, 2023)

This statement allows us to better circle back to the acoustic project of *The Little Scops Owl* and to Viktor Knud's such singular voice. According to Westerkamp's hypothesis, this voice would allow the listener to renew with the environments' spirit. It would make it possible to relate them, to render them, and in short, to access to an “ontological” type of listening, meaning a listening closest to the being of things:

I am sure that if we could hear real sounds, if we could put our ears next to the little scops owl this would be a joy for him [Knud Viktor] ... to hear it directly. But since they are very subtle sounds and we cannot disturb the animal, he used mikes. He brought us this experience via electronics. (Schryer)

This importance of the recording's space and time, here explained by Claude Schryer, is partly corroborated by Viktor who affirmed the necessity to preserve something of the sound take's context when composing. In 1985, he specified that "we cannot tear up a part of nature from its context without giving it another environment." He then goes on: "it means it must be submitted to the laws of a frame, like a picture frame. And for sound, it is the same thing. It requires a development of sound". (Adler)

4. Landscape aesthetic filtered by listening: towards a better ecologic understanding of the environments

The Little Scops Owl and all Viktor's sound recordings point out the reliefs and the complexities of unheard acoustic and endemic worlds that constitute our landscapes. Landscapes, one needs to be reminded, have long been grasped by a visual filter and have thus benefited, these last centuries, from a mainly ocular aesthetic treatment (for instance via landscape painting):

Does the soundscape simply repeat the visual landscape or does it indicate elements, dimensions or underestimated elements in the modern landscape as it is seen? As it is less studied and less traditionalized in our cultures, can the auditory perception be part of the paradigm of landscape beyond the modern? (Augoyard)

These questions asked in 1991 by the musicologist Jean-François Augoyard, who is close to Viktor, are still relevant today. It is evident that the "retinal dimension" (Barbanti, 2023) specific to the artistic treatment of landscape has invaded the whole of the creation and produced a rather detrimental heritage towards natural world representation:

Western landscape painting may have indeed contributed to crystallize this distanced relationship to the living world, by representing it as standing before us, outside of us, as a view to be contemplated. The regular use of linear perspective in western landscape painting has perhaps reinforced this feeling of man's exteriority. By proposing an image which virtually spreads from the unique eye of the looker facing the painting, it thus confers a sensation of control of the represented space and thus a domination of nature. (Zhong Mengual, 2021)

If Knud Viktor himself practiced landscape painting in Denmark and continued to experiment this genre when he arrived in the Luberon³⁵, we understand instantly that the way he grasps the world through sounds distinguishes itself very clearly from the heritage conveyed by this pictural genre such as it was established in the modern western painting.

For Viktor, the landscape is not just a simple "background of our tribulations" (Zhong Mengual, 2017); to the contrary, it constitutes a habitat³⁶ peopled with players gifted with sensitivities:

It is extraordinary because we can hear, thanks to the cicadas singing, the presence of small clouds. A cloud passes by, and everything starts to hobble. The rhythm is broken. [...] It was an unexpected discovery: in the end, the light was transforming into sound. (NightOwl, 2019)

5. Towards a vernacular "macroacoustic" and landscapes filled with subjectivities

The exteriority imposed by the use of normalized perspective in painting is thus thwarted by a phenomenal dive into the non-human acoustic worlds that Viktor's field recordings and acoustic works apply themselves to render. His work – both documents and compositions, or "constellations" (Adler) – establishes the landscape as a living environment, ours, but also the one of a myriad of living beings: *The Dreaming Rabbit, A Moving Snail, Two Snails*

³⁵ Several paintings and graphic works linked to the Luberon landscape are indeed present in the artist's archival fonds which is kept at the *Sound Art Lab*, in Struer (Denmark).

³⁶ In that sense, the word "ecology" is constructed from the greek *oikos*, which means "house", "habitat" and *logos*: "word".

Eating their Salad, The Love Song of Two Fruit Flies, A Fleeing Fox, A Chickadee Nest, A Worm Eating an Apple, The Fighting Ants, The Worms Eating Wood, or else The Hoopoe Pecking the Mike...

His participation to the *Jardin Planétaire* (Planetary Garden) exhibition curated by philosopher and gardener Gilles Clément in early 2000's (Grande Halle de la Villette, Paris) will give him the occasion of elaborating a peculiar listening device for this series of small biophonic sounds which are characterized, in Viktor's audiography, by these very evocative Haikus-like titles.

Accompanied by scenographer Raymond Sarti, the artist imagines for this large-scale exhibition (one of the first in France to clearly articulate aesthetic, philosophy, sciences and environmental issues), a sound installation displaying 80 bamboos equipped with small speakers on top of which the visitor can bend over to access these “small acoustic monuments” (Clément). The sketch below – drawn by the scenographer –, is one of the rare traces of this sound installation and Viktor's contribution to the *Jardin Planétaire* (Figure 2).



Figure 2

In 2007, that sound installation was rethought for the Contemporary Art Biennial of Melle (***Eau, air, terre : la sagesse du jardinier*** (Water, Air, Earth: The Gardener's Wisdom), an event also curated by Clément), and took the form of a dozen of old phone booths powered by solar energy. By entering the booth and picking up the phone, the auditor was caught up in the middle of a sort of “macroacoustic” (de la Croix) thanks to which the small sounds of the Mediterranean fauna were offered to them as so many immaterial and ephemeral offerings.

This display, conveniently entitled *Allô La Terre* (Hello Earth), amplified the idea that the microphone “revealed details, contrasts, and an acoustic profundity which was beforehand masked by vision [...] and] has a magnifying power” (Schaeffer). Embracing the aesthetic metaphor, it signified the reconnection between Man and his environment.

In the absence of rendering the temporality of the recording and allowing total access to more-than-human worlds which this “entomophonia” (Michel, 2016) represents, Viktor's set ups are like so many other bridges which, beyond the voice, allow to bring closer something of the perspectival experience lived by the sound technician. He comments:

With sound, we are transported into the world we are listening to. This is why I am saying I am banging my head when I want to enter a mousehole. After a while, we live with what we do. We lay there, flat on our stomach. We forget about our own size, and we live with what is happening. (NightOwl, 2019)

Here, we hear how Viktor's listening experience is far away from anthropocentrism which, in acoustic arts, could amount to "humanize other living beings by hearing their sounds as voices carrying meanings, and sooner or later becoming understandable by us and for us, humans", but also "to listen to them as acoustic objects aseptically dissociated (the ones from the others, from an environment, from a temporality)". (Barbanti et al., 2024: 60). It is obvious that Viktor's artistic propositions claim a local color and are to be read from the point of view of a localized listening and body, the sound technician's, Knud Viktor. A sound recorder who marvels about the singular banality of the environment he is living in and who manages to reveal what this "banality" contains of extraordinary, of wealth, of life and of murmur. Michel Giroud, friend, poet, artist and critic wrote in the text which accompanies the only monographic catalogue consecrated to Viktor so far: "the time of the miniscule explorations has begun, not to take possession, not to have knowledge and not to supposedly explain, but to live, far from the spectacular". (Giroud)

6. Listening and having others listen: music *is* nature

Beyond these macro sounds, what interest Viktor are the relations between the sounds, how they sustain each other: "I heard how all of nature's sonorities were searching to enter the same harmony. There is a balance which gives meaning, and then, it is a music of its own" (Varier). Behind these words can be read an underlying intuition which links Viktor's practice to the one of an Olivier Messiaen, of a François Bernard Mâche but also of a Bernie Krause (to quote only the main ones). As many acoustic actors who have developed the idea that nature and music were all the more linked than it appeared:

Music, contrary to an often-widespread idea, is not Man's own purely cultural product; it is a reality which exists first in the natural world and human beings only actualize some of its aspects. Thus, the musician's first function must be to apprehend the acoustic reality in all its extent and to attempt to carry it out at least partially, in their own productions. (Bayer)

Thus, Viktor's small sounds are sometimes integrated into his "sound images" which are territorialized and abstract compositions. The most famous example is *Image VI* or *Luberon Symphony* (1976). For example, the iteration of a hornet batting its wings allows him to recreate the illusion of a storm and the repetition of a water drop acoustic motif coupled to numerous transpositions (accelerations/slowing downs) are as many ways of evoking the vitality of the Durance (a river in the south of France). Indeed, it is the medley of an ensemble of details captured inside of a landscape which gives Viktor the possibility of returning the land's atmosphere: "you have to start from the small, worm who eats away, stone which vibrates, little scops owl who dusts its wings, in the end, you have to start from portraits to render a land". (Nadrigny)

From the infinitesimally small to the infinitely large stands out the artist's ability of multifocal listening. For example, *Image X* (1984) deals with erosion (geophonia), thus placing itself on the scale of geological times. This capacity greatly resonates with the notion of *Deep Listening* conceptualized by Pauline Oliveros. She defines it as the possibility of integrating the totality of the acoustic environment into one's own perceptive field and in a specific place by saving room to focalize on details of that same environment:

Deep Listening for me is learning to expand the perception of sounds to include the whole space/time continuum of sound – encountering the vastness and complexities as much as possible. Simultaneously one ought to be able to target a sound or sequence of sounds as a focus within the space/time continuum and to perceive the detail or trajectory of the sound or sequence of sounds. Such focus should always return to, or be within the whole of the space/time continuum (context). Such expansion means that one is connected to the whole of the environment and beyond. (Oliveros)

7. A sound workshop: crafting one's own sensibility

If the recording (and then editing and composing) operations have of course a limited impact on the direct listening of these acoustic environments, it is certain that how Viktor takes hold of them are meant to tighten the links to reality – links distended by the technological mediation. It is indeed not insignificant that Viktor learnt how to use technology to create tools corresponding to his own needs — he was immortalized in action by photographer Alain Sauvan (Figure 3). Thus, beyond the thousands of hours of recordings which archive the acoustic history of the Luberon landscape at the end of the last century, Viktor has invented strange capture devices: amplifiers cobbled together in old cigar boxes or old cans; satellite dishes conceived directly out the

mountain's rock walls (for instance when recording *Image X*) or elaborated out of washing boilers' lids; microphones made by collecting old televisions components, etc.

During his 1992 Montreal speech, Dhomont asked these questions: “Who among us is ready to restrain their craving for miracle-machines, to use old bits of magnetic tapes, to fill diskettes to the brim, to save electricity, to run the old harmonizer until its natural death?”. The name of Knud Viktor could easily adjust to this last question since his sound crafting, assuredly handmade, well integrates in this saving of means. Better than any high-end equipment, it offers him the liberty to carry out bigger acoustic experimentations: “I always content myself with small means like the micro-condensers of small portable tape recorders and things like that, which don't cost much. Because then, you can risk the mike's life!” (Adler). Thus, Viktor avoids the pitfall of the electroacoustic composer's practice pointed out by Dhomont in the next part of his speech: sometimes, the overuse of technology irretrievably impacts ecosystems.

If the issue of the electroacoustic composer's excessive usage of tools must obviously not be replaced by the larger one of unlimited consumerism which stems out from the generalized depletion of resources, it nevertheless remains important to underline that Viktor's attitude coincides with a deep attention, care and curiosity towards surrounding ecosystems.

The great proximity and complexity he developed throughout the years spent on this land which he almost never leaves and of which he knows every corner force him to recognize the damages caused for example by the insecticides which became available for the farmers of the region in the beginning of the 70's. “Back then in the Luberon, I would record five different species of cicadas. Today [in 2007], only two remain. It is because of climate change that these species disappeared. No more larvae, so no more cicadas”. (Texier)



Figure 3

8. Conclusion

Similarly, to the fight against pesticides which urged the American biologist Rachel Carlson to write her *Silent Spring* (1962) – which helped banning DDT in the U.S – what motivates Viktor's process beyond a certain scientific curiosity, and what urges him to record relentlessly, is the urgency and the necessity to keep a trace of the acoustic ambiances of his region. He explained:

I considered it as a work, almost a duty. I thought that the Luberon was going to be invaded by the industrial development of the Fos-sur-Mer site. So, I kept every sound for their poetic beauty and their strength, as documents. (Lecorre)

If these analyses made him the "pioneer" of acoustic ecology in France, we shall remark that the practical links he maintained within this movement were rarely made explicit. As a conclusion, we shall briefly remind some of them.

Apart from his participation to the 7th Spring of Electroacoustic of Montreal (1992), a year before the first great world conference on acoustic ecology entitled *The Tuning of the World*, Viktor also joined in the 1981 *Les États généraux du bruit* (*General Assembly of Noise*), an interdisciplinary festival dealing with the question of: "what if we learned to listen to noises instead of enduring them?" (Fleuret). The same year, Viktor participated in the exhibition *L'Oreille Oubliée* (*The Forgotten Ear*) (Centre Pompidou), one of the first shows to raise awareness on the issue of noise pollution to the general public. In 1985, he was present to the *Premier salon régional du confort acoustique* (*First Regional Fair of Acoustic Comfort*) taking place in Montpellier (with Pierre Mariétan and Luc Ferrari among others). Then, in 1993, he contributed to a symposium entitled *Quels paysages sonores demain ?* (*What acoustic landscapes tomorrow?*) in the city of Le Creuzot. Other talks followed, for example in Avignon in 2006 during the 7th meeting of Volubilis also dedicated to soundscape (in the presence of the same Mariétan but also of Jean-François Augoyard, Patrick Romieu or of the "sound tailor" Yann Parenthoën).

All of these participations attest to Viktor's belonging to the great family of acoustic ecology and draw an "augmented" map of this interdisciplinary movement which includes a galaxy of players – artists, philosophers, musicologists, experimenters. Like Viktor, they are as many "listeners" (Mathon) who consider listening to be a crucial perceptive mode to understand landscapes and environments and who invite us to learn to listen from their own attentive listening of the world.

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Αέρας και Ήχος: Ιστορικός Ήχος, Αρχαιολογικά και Ιστορικά Δεδομένα Μεταμορφούμενα σε Ηχητική Τέχνη

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Περίληψη

Το παρόν κείμενο αναφέρεται στη δημιουργία μιας ηχητικής εγκατάστασης βασισμένης σε ιστορικά και αρχαιολογικά δεδομένα. Η ηχητική εγκατάσταση συνδέει τον αέρα με το μουσικό όργανο ύδραυλη, το οποίο εκτίθεται στο Αρχαιολογικό Μουσείο Δίου, και χρησιμοποιεί τον αέρα μέσω ενός υδραυλικού μηχανισμού για να παράγει ήχο. Η εγκατάσταση ενσωματώθηκε στην τελευταία θεματική του εκπαιδευτικού προγράμματος «Πνοές Ανέμων: Η συμβολή του Αέρα στη Μουσική», που υλοποιήθηκε το 2017 από την Εφορεία Αρχαιοτήτων Πιερίας στο Αρχαιολογικό Μουσείο Δίου, στο πλαίσιο της επικοινωνιακής δράσης «Περιβάλλον και Πολιτισμός» του Υπουργείου Πολιτισμού.

Το κείμενο δομείται σε δύο μέρη: Στο πρώτο μέρος, η αρχαιολόγος Ελένη Γεροφωκά εστιάζει στα ιστορικά και αρχαιολογικά δεδομένα για την αρχαία ύδραυλη. Συγκεκριμένα, αναφέρεται σε αρχαίες ιστορικές και λογοτεχνικές πηγές, καθώς και σε αρχαιολογικά ευρήματα, όπως εικονογραφικές παραστάσεις σε ψηφιδωτά δάπεδα και τα κατάλοιπα αρχαίων οργάνων. Ιδιαίτερα, οι λογοτεχνικές πηγές αναδεικνύουν τον ήχο της ύδραυλης και την ηχητική της διάσταση, επιτρέποντάς μας να φανταστούμε πώς μπορεί να ακουγόταν σε διαφορετικά περιβάλλοντα.

Στο δεύτερο μέρος παρουσιάζεται το έργο του συνθέτη και καλλιτέχνη ήχου Δημήτρη Μπάκα, με το οποίο τα ιστορικά και αρχαιολογικά δεδομένα μετουσιώθηκαν σε ηχητικό έργο τέχνης. Ο καλλιτέχνης χρησιμοποιεί αρχές της Ακουστικής Οικολογίας και Οντολογίας Τεχνών για να κατασκευάσει μια ηχητική εγκατάσταση που στοχεύει να αφυπνίσει την ιστορική μνήμη του ακροατή. Στο πλαίσιο αυτό το έργο αντί να εξετάζει το πεδίο των ιστορικών μουσικών δεδομένων εστιάζει σε μια πιο αμφίβολη περιοχή ερμηνείας, τα ιστορικά ηχητικά δεδομένα. Συγκεκριμένα, εστιάζοντας στον ήχο και όχι στη μελωδία, παρατηρεί μέσα από τις καταγραφές, τα ηχητικά χαρακτηριστικά της ύδραυλης και επιχειρεί συνθετικά να συνδέσει τον ήχο της με το ιστορικό της πλαίσιο, αναδεικνύοντας την οντολογία του οργάνου, τον λόγο και τη φύση του, μέσα από μια εικαστική ματιά.

Λέξεις κλειδιά

Ύδραυλη, υδραυλικό όργανο, ηχητική τέχνη, ιστορικός ήχος

Α ΜΕΡΟΣ

1. Εισαγωγή

Το μουσικό όργανο που οι αρχαίοι Έλληνες ονόμαζαν *Ύδραυλις* αποτελεί ένα τεχνολογικό «θαύμα» της ελληνιστικής περιόδου, έναν συνδυασμό γνώσεων της φυσικής και της τεχνολογίας των υλικών. Η ύδραυλη

βασίζεται σε έναν υδραυλικό μηχανισμό που εξασφαλίζει σταθερή ροή αέρα για την παραγωγή ήχου. Η ύδραυλη είναι το πρώτο ηλεκτροφόρο μουσικό όργανο στην παγκόσμια ιστορία. Πρόκειται για ένα όργανο ακριβείας που αντανakλά την καινοτόμο σκέψη της εποχής δημιουργίας του. Παρά το γεγονός ότι θεωρείται ένα από τα πιο συναρπαστικά και πολύπλοκα αρχαία μουσικά όργανα, το ρεπερτόριό της και οι μουσικές συνθέσεις που εκτελούνταν σε αυτήν παραμένουν σε μεγάλο βαθμό άγνωστα. Στο παρόν κείμενο, βάσει πρωτογενών και δευτερογενών ιστορικών πηγών και αρχαιολογικών ευρημάτων, γίνεται μια σύντομη και συνοπτική παρουσίαση της ύδραυλης. Εστιάζει ιδιαίτερα στον ήχο της ύδραυλης και στην ηχητική της διάσταση, η οποία εξετάζεται μέσω λογοτεχνικών πηγών που μας βοηθούν να φανταστούμε πώς ακουγόταν σε ποικίλα περιβάλλοντα.

2. Η Ύδραυλη: Ιστορικά και Αρχαιολογικά δεδομένα

2.1. Προέλευση και Ονομασία

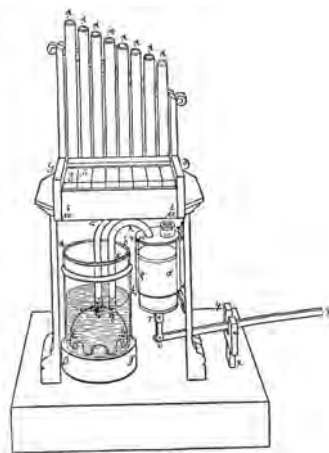
Η ύδραυλις ήταν γνωστή και ως ύδραυλος ή ὄργανον ύδραυλικόν. Σε δύο πηγές του 3ου αι. μ.Χ. απαντά με τη συντομογραφία Ὑδρα/*Hydra*, ενώ από τον 4ο αι. μ.Χ. αποκαλείται απλώς ὄργανον/*organum* (West, 1992:114). Σχεδόν όλες οι πηγές αναφέρουν ως εφευρέτη της ύδραυλης τον Έλληνα μηχανικό Κτησίβιο που έζησε στην Αλεξάνδρεια τον 3ο αι. π.Χ. Την εποχή αυτή η Αλεξάνδρεια αποτελούσε παγκόσμιο επιστημονικό κέντρο με ιδιαίτερη ανάπτυξη στα επιτεύγματα της υδραυλικής μηχανικής (Arel, 1948:192).

Δυστυχώς, όλα τα γραπτά του Κτησίου έχουν χαθεί, και οι γνώσεις μας για την κατασκευή της προέρχονται από τα αρχαιολογικά ευρήματα, τις σποραδικές αναφορές στις αρχαίες πηγές, αλλά κυρίως από δύο σωζόμενες αναλυτικές περιγραφές για την ύδραυλη του 1ου αι. μ.Χ.: του Ήρωνα του Αλεξανδρινού (*Πνευματικά*, 1. 42) και του Βιτρούβιου (*De Architectura*, 10. 8). Η παλαιότερη αναφορά στην ύδραυλη απαντά τον 3ο αι. π.Χ., στα *Βελοποιίκα* του Φίλωνα του Βυζάντιου, ο οποίος την περιγράφει ως τη «σύριγγα που παίζεται με τα χέρια» (Φίλωνας, 260-180 π.Χ./1919, σ. 66).

2.2. Δομή και Εξέλιξη

Σύμφωνα με την περιγραφή του Ήρωνα (*Πνευματικά*, 1. 42) η ύδραυλη αποτελούταν από μια αντλία (πυξίς με εμβολέα) η οποία συμπιέζε τον αέρα και τον διοχέτευε σε ένα χάλκινο δοχείο (βωμίσκος) γεμάτο νερό, στον πυθμένα του οποίου υπήρχε ένα ανεστραμμένο μεταλλικό ημισφαίριο (πνιγεύς), που συγκρατούσε τον πεπιεσμένο αέρα και με τη βοήθεια του νερού, διατηρούσε την πίεση σταθερή. Ακολουθούσε ένα επίμηκες κιβώτιο με μηχανισμό που κατέληγε σε ένα ηλεκτρολόγιο από όπου γινόταν η διανομή του πεπιεσμένου αέρα σε μία ή περισσότερες συστοιχίες ανισομηκών μεταλλικών σωλήνων (αυλών) που ήταν τοποθετημένοι όρθιοι πάνω από τα πλήκτρα (Εικόνα 1).

Οι γραπτές πηγές δεν παρέχουν σχεδόν ποτέ πληροφορίες σχετικά με την εξωτερική εμφάνιση του οργάνου. Αυτές προέρχονται κυρίως από τις εικονογραφικές παραστάσεις σε ψηφιδωτά δάπεδα, αγγεία, επιτύμβιες στήλες και άλλα (Perrot, 1971) οι οποίες δείχνουν πως η όλη κατασκευή ήταν κρυμμένη σε ένα ξύλινο τετράγωνο ή εξάγωνο κιβώτιο, που είχε ύψος περίπου ένα μέτρο και εδραζόταν πάνω σε βάθρο (West, 1992). Βλέπε ενδεικτικά παρακάτω (Εικόνες 2, 3, 4).



Εικόνα 1. Η ύδραυλη στα *Πνευματικά* του Ήρωνα. Διάταξη 1. 42. (Schmidt, 1899)

Κατά τον 2ο αι. μ.Χ. το υδραυλικό σύστημα αντικαταστάθηκε από έναν ασκό που φουσκωνόταν με τη χρήση φουσέρας και το όργανο έγινε πνευματικό, πιο ελαφρύ και επομένως πιο εύκολο στη μεταφορά (West, 1992: 117). Από την αρχή, τα όργανα με φουσάνα χρειάζονταν μηχανισμό ελέγχου της πίεσης του αέρα, αλλά η δυνατότητα τροφοδοσίας μεγαλύτερων οργάνων επιτεύχθηκε μόνο με την ανάπτυξη πιο προηγμένων συστημάτων ρύθμισης αιώνες αργότερα. Για τον λόγο αυτό, τα αρχαία πνευματικά όργανα ήταν συνήθως μικρής κλίμακας (Perrot, 1971: 52).

Το 2ο αι. μ.Χ. ο Ιούλιος Πολυδεύκης (*Ονομαστικόν*, 4. 70) κάνει σαφή διάκριση μεταξύ του υδραυλικού και του πνευματικού οργάνου. Το όργανο με φουσάνα το ονομάζει *τυρρηνό αύλό* και το χαρακτηρίζει ως μικρότερο από το υδραυλικό το οποίο είχε πολλές νότες «πολύφωνος» και ο ήχος ήταν πιο έντονος «ίταμώτερον». Σύμφωνα με τον Hagel (2023: 54, υποσημ. 8) ο όρος πολύφωνος υποδηλώνει την ικανότητα της ύδραυλης να παράγει ταυτόχρονα πολλούς ήχους. Ο ίδιος αναφέρει ότι ο σχεδιασμός της επέτρεπε την εκτέλεση πολλών φθόγγων, εισάγοντας σύνθετες μελωδίες και πολυφωνικά ακούσματα, προάγοντας τις ηχητικές δυνατότητες της εποχής.

2.3. Διάδοση και Χρήση

Η ύδραυλη θεωρήθηκε αρχικά μηχανικό θαύμα, όμως σύντομα αναγνωρίστηκε για τις μουσικές της δυνατότητες. Μετά την εφεύρεσή της διαδόθηκε γρήγορα στον ελληνιστικό κόσμο και αργότερα στη Ρωμαϊκή Αυτοκρατορία και έγινε δημοφιλής στο κοινό του θεάτρου και την αυτοκρατορική αυλή. Ιδιαίτερα ο Νέρωνας ήταν ενθουσιώδης θαυμαστής και χρήστης της ύδραυλης (Perrot, 1971). Η ύδραυλη εξαφανίστηκε από το δυτικό τμήμα της παλιάς Ρωμαϊκής Αυτοκρατορίας κατά τους πρώτους χριστιανικούς αιώνες, αλλά συνέχισε να επιβιώνει στο Βυζάντιο ως πνευματικό όργανο, και ενσωματώθηκε στο πρωτόκολλο της αυτοκρατορικής αυλής, από όπου και επέστρεψε στη Δύση τον 8ο αι. μ.Χ. Στο Βυζάντιο ήταν σε χρήση έως την πτώση της αυτοκρατορίας (Παντερμαλής, 1992, 2003).

Η ύδραυλη ήταν παρούσα τόσο σε ιδιωτικούς χώρους όσο και σε δημόσιους. Ακουγόταν σε θέατρα, τσίρκα, και συμπόσια. Ήδη από τον 1ο αι. π.Χ., συμμετείχε σε συναυλίες όπως προκύπτει από μια δελφική επιγραφή (*Syll.*³ 737) που χρονολογείται το 94 π.Χ. και αναφέρεται στην επιτυχία του Αντίπατρου, ενός δεξιότεχνη χειριστή της ύδραυλης, ο οποίος από την Ελεύθερνα της Κρήτης έφτασε στους Δελφούς για να πάρει μέρος σε μια συναυλία (Chaniotis, 2009: 88). Ενώ, η συμμετοχή της σε θρησκευτική λατρεία αναφέρεται μόνο σε μια ελληνική επιγραφή (*OJh* VII, 92) από τη Ρόδο που χρονολογείται τον 3ο αι. μ.Χ. όπου με τη μουσική της ξυπνούσε το άγαλμα του θεού Βάκχου μέσα στο ναό του (Παντερμαλής, 1992: 219, Perrot 1971: 55-56).

Η ύδραυλη χρησιμοποιήθηκε επίσης στα μεγάλα αμφιθέατρα για να συνοδεύσει αγώνες μονομάχων. Αυτή η λειτουργία της επιβεβαιώνεται για τον 1ο αι. μ.Χ. από μια αναφορά στο *Σατυρικόν* του Πετρώνιου, ο οποίος περιγράφει μια σκηνή από το «*Δείπνο του Τριμαλχίωνα*» κατά τη διάρκεια του οποίου ένας υπηρέτης χαράζει το κρέας υπό τον ήχο της μουσικής με τέτοιες χειρονομίες, όπως ένας μονομάχος πολεμούσε πάνω στο άρμα υπό τον ήχο μιας ύδραυλης (Πετρώνιος, 1ος αι. μ.Χ./2000, σ. 25). Αυτού του είδους η χρήση θα δικαιολογούσε όργανα μεγαλύτερα σε μέγεθος και με πιο δυνατό ήχο, έτσι ώστε να μπορούν να ακουστούν πάνω από τον θόρυβο ενός άρματος που πηγαίνει με πλήρη ταχύτητα (Perrot 1971: 49-50).

Η χρήση του υδραυλικού οργάνου στο αμφιθέατρο επιβεβαιώνεται κυρίως όμως από τις εικονογραφικές μαρτυρίες που δείχνουν ότι το όργανο απεικονίζεται συχνά στο περιβάλλον του αμφιθέατρου, συνοδευόμενο μερικές φορές από διαφόρων ειδών σάλπιγγες (Perrot, 1971: 50). Ενδεικτικά αναφέρουμε τα ψηφιδωτά δάπεδα του Nennig (2ος -3ος αι. μ.Χ.) και του Zliten (1ος - 2ος αι. μ.Χ.). Στο ψηφιδωτό του Nennig (Εικόνα 2), το οποίο βρέθηκε σε ρωμαϊκή έπαυλη στο Nennig, κοντά στο Saarland της Γερμανίας, σε μια σκηνή απεικονίζεται μια ορχήστρα με δύο άνδρες μουσικούς, όπου ο ένας παίζει ύδραυλη και ο άλλος σάλπιγγα (Dunbabin, 1999: 81, Perrot, 1971: 73-75).



Εικόνα 2. Ψηφιδωτό δάπεδο Nennig (λεπτομέρεια)

Ενώ, στο ψηφιδωτό δάπεδο του Zliten (Εικόνες 3-4), που βρέθηκε σε ρωμαϊκή έπαυλη στην πόλη Zliten στη Λιβύη απεικονίζονται δύο ορχήστρες με τρεις σάλπιγγες και ένα υδραυλικό όργανο, το οποίο παίζουν γυναίκες (Dunbabin, 1978: 65, Perrot, 1971:75-77).



Εικόνα 3. Ψηφιδωτό δάπεδο Zliten: Α' ορχήστρα (λεπτομέρεια)



Εικόνα 4. Ψηφιδωτό δάπεδο Zliten: Β' ορχήστρα (λεπτομέρεια)

2.4. Αρχαιολογικά κατάλοιπα αρχαίων οργάνων

Αρχαιολογικά λείψανα μόνο τριών πραγματικών οργάνων έχουν μέχρι στιγμής ανασκαφεί: Το 1931 στο Aquinsum (Ουγγαρία), το 1992 στο Δίον (Πιερία) και το 1996-2005 στο Avenches /Aventicum (Ελβετία). Τα όργανα του Aquinsum και του Aventicum χρονολογούνται στον 3ο αι. μ.Χ., παρουσιάζουν πολλές ομοιότητες μεταξύ τους (de Pury-Gysel, 2008) και πιθανόν να πρόκειται για πνευματικά όργανα και όχι για υδραυλικά (Παντερμαλής 2003).

Η ύδραυλη του Δίου ανακαλύφθηκε από τον καθηγητή κ. Δ. Παντερμαλή το 1992, στις ανασκαφές στο αρχαίο Δίον και χρονολογείται στον 1ο αι. π.Χ. Διατηρεί το πάνω μέρος ενός οργάνου που αποτελείται από μια βάση, κατασκευασμένη από δύο χάλκινες οριζόντιες πλάκες, που στηρίζει μια σειρά 24 κυλινδρικών αυλών στη συνέχεια των οποίων υπάρχουν 16 μικροί, ισούψείς αυλοί χωρίς χείλη. Οι διαστάσεις του συστήματος των αυλών είναι 1,20 μ. x 0,70 μ. (Παντερμαλής, 1992, 2003). Σύμφωνα με τους μελετητές της ανακατασκευασμένης ύδραυλης του Δίου, οι 16 μικροί αυλοί πιθανόν να τοποθετηθήκαν για αισθητικούς λόγους ή για να παράγουν ηχητικά εφέ, όπως για παράδειγμα ήχους πουλιών (Καρασμάνης, 2005).



Εικόνα 5. Η ύδραυλη του Δίου (Παντερμαλής, 1992)

3. Ο ήχος της ύδραυλης

3.1. Ο ήχος της ύδραυλης. Αρχές Ακουστικής

Αν και γνωρίζουμε αρκετά για την κατασκευή της ύδραυλης, οι γνώσεις μας για τον ήχο της και τις συνθέσεις που εκτελούνταν σε αυτήν είναι ελάχιστες. Οι μελετητές αποδίδουν αυτό το κενό σε δύο κυρίως λόγους: Πρώτον, οι κύριες περιγραφές για την κατασκευή και τη λειτουργία της προέρχονται από τεχνικούς (Ηρώνας Αλεξανδρινός και Βιτρούβιος) οι οποίοι εστίασαν στη μηχανική πλευρά του οργάνου και όχι στις μουσικές του εφαρμογές. Δεύτερον, οι αρχαίοι θεωρητικοί δεν έκριναν αναγκαίο να καταγράψουν τις λεπτομέρειες της ακουστικής των αυλών, δεδομένου ότι ίσχυαν οι ίδιοι κανόνες με εκείνους των δονούμενων χορδών.

Ο Νικόμαχος ο Γερασηνός (*Αρμονικόν Εγχειρίδιον*, 6. 1 κ. έξ.) που έζησε τον 2ο αι. μ.Χ., μας λέει ότι ο Πυθαγόρας είχε εφαρμόσει αυτούς τους κανόνες στον αυλό, στη σύριγγα, καθώς επίσης σε πλήθος εγχόρδων μουσικών οργάνων, ενώ, τον 3ο αι. μ.Χ., ο Πορφύριος ο Τύριος (*Εις τα αρμονικά Πτολεμαίου υπόμνημα*, 119. 25) υπενθυμίζει τις γενικές αρχές της ακουστικής όπως ισχύουν για τον αυλό και προσθέτει ότι παρόμοιο αποτέλεσμα προέκυψε από την Ύδρα, όπου οι ήχοι παράγονταν από ανισοϋψείς σωλήνες που ήταν προσαρτημένοι στο όργανο (Πορφύριος, 3ος αι. μ.Χ. /2015, σ. 361).

Αν και δεν διαθέτουμε αρχαίες παρτιτούρες ή πραγματείες για τη μουσική της ύδραυλης, αυτή η ελάχιστη καταγραφή υποδηλώνει ότι η ύδραυλη κατασκευάστηκε με σκοπό να αποδίδει συγκεκριμένα μουσικά διαστήματα, βασισμένα στις θεμελιώδεις αρχές της ακουστικής.

3.2. Ο ήχος της ύδραυλης μέσα από τις λογοτεχνικές πηγές

Το υδραυλικό όργανο άσκησε σημαντική γοητεία και έλξη στη φαντασία των ποιητών και των συγγραφέων, οι οποίοι συχνά περιγράφουν τον ήχο του στα έργα τους, χρησιμοποιώντας διάφορα σχήματα λόγου. Θα παραθέσουμε μερικές από τις αρχαίες λογοτεχνικές πηγές, στην προσπάθεια να αποδώσουμε μια αίσθηση του ήχου του οργάνου, ο οποίος, σύμφωνα με την παράδοση που αναφέρει ο Πλίνιος (*Naturalis Historia*, 9. 8), γοήτευε περισσότερο από όλες τις μελωδικές συναυλίες τα δελφίνια, τα οποία λάτρευαν τη μουσική.

Στο ψευδο-βεργιλανό ποίημα (*Aetna*, 295-300) που πιθανόν χρονολογείται στο πρώτο μισό του 1ου μ.Χ., ο ποιητής σε ένα απόσπασμα που περιέχει αναφορές της Αίτνας στο πλαίσιο των ακουστικών χαρακτηριστικών του βουνού, συζητά τις αρχές της ροής του αέρα και της πίεσης μέσα στο ηφαιστειακό σύστημα και συγκρίνει τον περιβαλλοντικό θόρυβο της ηφαιστειακής δραστηριότητας με τον τρόπο με τον οποίο παράγεται και ενισχύεται ο μουσικός ήχος του υδραυλικού οργάνου (Kruschwitz, 2015). Ειδικότερα, ο ήχος θύμιζε στον ποιητή τους θορυβώδεις, μονότονους ήχους που παράγει το υδραυλικό όργανο που χρησιμοποιούταν στα μεγάλα θέατρα: «καί όπως στα μεγάλα θέατρα, το όργανο τραγουδά το υδραυλικό του τραγούδι, παίζοντας μελωδίες με τους διαφορετικούς μήκους σωλήνες του, μέσω της δεξιοτεχνίας του παίκτη, ο οποίος κάνει μια κωπηλατική κίνηση στο νερό και έτσι θέτει σε κίνηση το ήπιο ρεύμα του αέρα, με τον ίδιο ακριβώς τρόπο που ο άνεμος,

εκτοπισμένος από τα ρεύματα του νερού, οργίζεται και {300} μάχεται στα στενά του όρια, και η Αίτνα βρυχάται δυνατά» (*Aetna*, 1ος αι. μ.Χ./2012, σ. 320-321).

Το 160-230 μ.Χ. ο Τερτυλλιανός στο (*De Anima*, 14) αντιτίθεται στον πολλαπλό διαχωρισμό της ψυχής σε μέρη από τους φιλοσόφους και στην προσπάθειά του να υποστηρίξει την ενότητά της αναφέρεται στο υδραυλικό όργανο: «τόσα πολλά μέλη, τόσοι πολλοί σύνδεσμοι, τόσοι πολλοί αγωγοί ήχου, τόσοι πολλοί συνδυασμοί τόνων, τόσες πολλές ανταλλαγές τρόπων (*commerciorum modorum*), τόσες πολλές σειρές σωλήνων, και όλα σχηματίζονται μία δομή». Ο J. Perrot υποστηρίζει πως μια πιο ορθολογική απόδοση του (*commerciorum modorum*), θα ήταν «ανταλλαγή νοτών» (Perrot, 1971:51).

Το 220 μ.Χ. ο Αθήναιος (*Δειπνοσοφισταί*, 4. 75) περιγράφει μια ζωντανή σκηνή από το συμπόσιο των Δειπνοσοφιστών, όπου ο «*ήδύς*» καὶ «*τερπνός*» ήχος της ύδραυλης, που ακουγόταν από ένα γειτονικό σπίτι, απέσπασε την προσοχή των συνδαιτυμόνων, οι οποίοι γοητεύτηκαν από τη μελωδία. Προφανώς, το όργανο που αναφέρεται εδώ είχε έναν γλυκό και ευχάριστο ήχο, και πολύ πιθανόν να ήταν μικρού μεγέθους, κατάλληλο για οικιακή χρήση (Apel, 1948:197-198). Παράλληλα, όμως, παρήγαγε επαρκή ένταση ήχου, έτσι ώστε να ακούγεται πάνω από τον θόρυβο των συζητήσεων (Perrot, 1971:55).

Στις αρχές του 4ου αι. μ.Χ., ο Οπτατιανός Πορφύριος έγραψε έναν Πανηγυρικό αφιερωμένο στον αυτοκράτορα Κωνσταντίνο Α'. Πρόκειται για ποιήματα που περιλαμβάνονται στη συλλογή γνωστή ως *Carmina* ή *Carmina Figurata* (Squire, 2017). Σε τρία από αυτά τα οπτικά ποιήματα, ο ποιητής, με αριθμητική πρόοδο, σχηματίζει μετρικά συνεπείς γραμμές που αναπαριστούν, με τη σειρά τους, έναν βωμό, μια σύριγγα και ένα όργανο. Το ποίημα σε σχήμα οργάνου αναπτύσσεται σε γραμμές που επιμηκύνονται σταδιακά, μιμούμενες την κανονική εξέλιξη των σωλήνων ενός οργάνου (Squire, 2017: 61–63). Ένα απόσπασμα από τους στίχους (*Carmen 20b*, στον Muller, 1877), που σχηματίζουν τους σωλήνες, όπως αναφέρεται στον Perrot (1971: 57), έχει ως εξής: «Προκύπτει λοιπόν μια ηχητική συμφωνία, ρυθμική και κατάλληλη για τραγούδια, ικανή να ακολουθεί τα ανοιχτά πλήκτρα που τρέμουν ποτέ στο παραμικρό άγγιγμα ή να συνάγει ευχάριστες μελωδίες. Τώρα όλος ο κόσμος θα θαμπωθεί από το μέτρο και ρυθμούς του».

Το 399 μ.Χ. ο Κλαύδιος Κλαυδιανός στο (*Panegyricus dictus Manlio Theodoro consuli*, 17. 316-319) αντιπαραβάλλει τους δυνατούς ήχους που παράγει το όργανο με το ελαφρύ άγγιγμα του οργανοπαίκτη: «και εκείνος του οποίου το ελαφρύ άγγιγμα μπορεί να προκαλέσει δυνατή μουσική από τους χάλκινους σωλήνες που παράγουν χίλιες διαφορετικές νότες κάτω από τα περιπλανώμενα δάχτυλά του, και εκείνος που με τη βοήθεια ενός μοχλού κινεί το νερό να τραγουδήσει» (Κλαύδιος, 399 μ.Χ./1922, σ. 361).

Κλείνοντας, είναι φανερό ότι το υδραυλικό όργανο, σε όλη του την ποικιλομορφία, αποτέλεσε μια ηχηρή έκφραση τεχνοκρατικής δύναμης, λειτουργώντας ως σύμβολο καινοτομίας, πολυτέλειας και πολιτιστικής ακτινοβολίας. Ο ήχος του, διαπεραστικός και μελωδικός, ανέδειξε την τεχνολογία του και άφησε το αποτύπωμά του στον μουσικό κόσμο, ενισχύοντας τον δεσμό μεταξύ της επιστήμης και της τέχνης, δημιουργώντας μια κληρονομιά που επηρέασε τη μουσική εξέλιξη στην Ευρώπη και πέρα από αυτήν.

4. Αναφορές

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Β ΜΕΡΟΣ

1. Εισαγωγή

Το έργο *Πνοή*, είναι ένα ηχητικό έργο τέχνης που χρησιμοποιεί ως βάση δημιουργίας, αρχές της Ακουστικής Οικολογίας και της Οντολογίας Τεχνών και χρησιμοποιείται ως Εγκατάσταση σε συγκεκριμένο χώρο στο Μουσείο του Δίου. Η κεντρική ιδέα με την οποία κατασκευάζεται το ηχητικό περιβάλλον είναι η έννοια του ιστορικού ήχου, ως μέρος της Ιστορικής μνήμης, μέσω εύρεσης και ανάλυσης ιστορικών δεδομένων που σχετίζονται με τον αέρα και την ύδραυλη, που μεταφράζονται με έναν μουσικό τρόπο.

2. Θεωρητικό Υπόβαθρο: Οντολογία Τεχνών, Ιστορικός Ήχος και Ακουστική Οικολογία

2.1. Οντολογία Τεχνών

Η οπτική γωνία μέσα από την οποία προσεγγίζω την Οντολογία Τεχνών, έχει ως βάση τη φιλοσοφική/θεολογική θεώρηση που εκφράζει ο θεολόγος Άγιος Μάξιμος ο Ομολογητής, ότι κάθε πλάσμα/αντικείμενο έχει μια λογική κατασκευής, έναν λόγο (Lossky, 1991) σύμφωνα με τον οποίο λειτουργεί με ένα συγκεκριμένο τρόπο. Αυτός του δίνει την υπαρξιακή του λειτουργική ταυτότητα και εκφράζει τον εαυτό του με βάση αυτόν. Αυτή του όμως η λειτουργική ταυτότητα δεν δικαιώνει το *ον/αντικείμενο a priori*, αλλά αποτελεί ουσιαστικά μια δυνατότητα (λειτουργίας). Δια αυτής και σε συνάρτηση με τον παράγοντα χρόνο, το αντικείμενο/πλάσμα έχει μια δυναμική προοπτική και φορτίζεται με μνήμες, ζωή. Αυτές οι μνήμες μπορούν να χωριστούν σε δύο κατηγορίες:

α) *Μνήμες της κατασκευής ή δημιουργίας*, πχ ένα μεταλλικό αντικείμενο, όπως σωλήνας νερού, φέρει πάνω του της μνήμες κατασκευής μέσα σε ένα εργοστάσιο. Σε αυτές τις μνήμες συμπεριλαμβάνονται και ηχητικές μνήμες που δημιουργήθηκαν κατά την ώρα της κατασκευής. Αυτό σημαίνει ότι πίσω από την ορατή στατική φύση ενός αντικειμένου, υπάρχει 'εγγεγραμμένη' πάνω του η δυναμική φύση της διαδικασίας κατασκευής

β) *Μνήμες της λειτουργικότητάς του*, στην καθημερινή ζωή, σε συνάρτηση με τον άνθρωπο. Και αυτές οι μνήμες συμπεριλαμβάνουν και ηχητικές μνήμες.

Όλα τα παραπάνω, δίνουν μια ξεχωριστή ταυτότητα σε κάθε τόπο/αντικείμενο και συνθέτουν ένα είδος «μυστικής παρουσίας» (*genius loci*) την οποία ο καλλιτέχνης είναι απολύτως αναγκαίο να αντιληφθεί και να λάβει υπ' όψιν του για τη δημιουργία ενός έργου. Όπως έλεγε και ο Alexandre Pore, το «*genius loci*» (πνεύμα του τόπου) πρέπει να «εισακουστεί». Κατά ανάλογο τρόπο, το πνεύμα του αντικειμένου/κτηρίου, κ.λπ., πρέπει να εισακουσθεί.

2.2. Ιστορικός ήχος και Ακουστική Οικολογία

Σύμφωνα με την Ακουστική Οικολογία, όλοι οι ήχοι ενός συγκεκριμένου πεδίου (μηχανικοί ήχοι, γεωλογικοί ήχοι, ανθρωπογενείς ήχοι, κλπ.) βρίσκονται σε μια συνεχή ρυθμική και χωρική δυναμική κατάσταση, δημιουργώντας έναν ζωντανό οργανισμό που αποτελεί το *ηχοτοπίο*, (π.χ. ήχοι στο δάσος). Μπορεί να το ακούσει κάποιος σαν ένα είδος μουσικής.

Στο πεδίο της Ιστορίας, το ηχοτοπίο, μπορεί να θεωρηθεί ως ένα φανταστικό πεδίο ήχων, και ανιχνεύεται μέσα από κείμενα και ευρήματα. Μέσα από αυτήν την προοπτική, σε ότι έχει σχέση με την ύδραυλη, επικεντρωνόμαστε στα ιστορικά δεδομένα ήχου μέσα από καταγραφές, και όχι στη μελωδία ή το σύστημα βάση του οποίου δημιουργήθηκε μια μελωδία. Σε τελευταία ανάλυση, ο ήχος και όχι η μελωδία, είναι οντολογικό χαρακτηριστικό του οργάνου, που απορρέει ως ενέργημα από τη λειτουργικότητά του (τον λόγο του). Αυτές οι ιστορικές καταγραφές αποτελούν τον ιστορικό ήχο.

2.2.1. Βασικά Ιστορικά Δεδομένα Ήχου Ύδραυλης: Χρήση Υφής αντί Μελωδίας

Το ενδιαφέρον είναι ότι όλες οι περιγραφές που βρήκαμε με την Ε. Γεροφωκά για την ύδραυλη, σχετίζονται πράγματι μόνο με δύο στοιχεία: την κατασκευή της και τον ήχο της. Αυτό ήταν πολύ ενδιαφέρον και ίσως μια ισχυρή ένδειξη ότι οι αρχαίοι Έλληνες δεν αναζητούσαν μόνο ένα σύστημα κλίμακας (τρόπους) η ρυθμό, αλλά ενδιαφερόταν πάρα πολύ για τον ήχο ενός οργάνου, σε σχέση με έναν χώρο: διαφορετικές χρήσεις, σε διαφορετικούς χώρους (σε σπίτια, σε αμφιθέατρο, σε ιππόδρομο, κ.λπ.). Σύμφωνα με τον West (2004)

υπάρχουν αναφορές για μια γιγαντιαία *Hydraulis*, με βροντερό ήχο που θα μπορούσε να ακουστεί από ένα μίλι μακριά. Προφανώς ένα όργανο αυτού του βεληνεκού δεν κατασκευάστηκε για τη χρήση μελωδίας. Αυτό ίσως είναι μια απόδειξη για την παραπάνω υπόθεση. Μάλιστα σε αυτή την περίπτωση μιλάμε για ένα *ηχητικό σήμα*, έναν ήχο δηλαδή που φέρει μια πληροφορία (π.χ. η καμπάνα μιας εκκλησίας μας πληροφορεί για την αρχή μιας ακολουθίας και άρα την ώρα, ή ο ήχος ενός ασθενοφόρου). Τελικά ένας τέτοιος ήχος, για μια συγκεκριμένη περιοχή χρήσης αποτελούσε και ένα *ηχόσημο*.

Χαρακτηριστικό είναι και το παράδειγμα εικονογραφίας που αναφέρει η Γεροφωκά, όπου η ύδραυλη εμφανίζεται στο αμφιθέατρο συνοδευόμενη από διαφόρων ειδών σάλπιγγες, που είναι ένδειξη ότι είχε οξύ ήχο, διαπεραστικό δηλαδή και ότι χρησιμοποιούνταν για ηχητικά εφέ και όχι για χρήση μελωδίας. Εξάλλου κάτι τέτοιο επιβεβαιώνει και το ψευδο-βεργιλιανό ποίημα (*Aetna*, 295-300), που αναφέρεται στους θορυβώδεις, μονότονους ήχους που παράγει το υδραυλικό όργανο που χρησιμοποιούταν στα μεγάλα θέατρα.

Μάλιστα σύμφωνα με τον Καρασμάνη (2005), στην ύδραυλη του Δίου υπήρχαν 16 έξτρα σωλήνες, όπου ίσως χρησιμοποιούνταν για τη δημιουργία εφέ, ήχους πουλιών, κλπ. Αυτά ήταν αποφασιστικά στοιχεία για να δημιουργήσω ένα έργο όχι απλά χωρίς μελωδία, αλλά με υφές, που προσομοιάζει το ηχητικό εφέ.

2.2.2. Οντολογική Προσέγγιση του Οργάνου και Στόχος

Οντολογικά μιλώντας, με βάση τις παραπάνω παρατηρήσεις, ο στόχος του έργου ως προς το όργανο (ύδραυλη), είναι το να αναδείξει την ταυτότητα του οργάνου, τον λόγο του και τη φύση του: Το πρώτο ικανοποιείται από την ύπαρξη του ως όργανο που επιθυμεί να *ακουστεί* ως έχει, δηλαδή ως πολύαυλος με οξύ αλλά και γλυκό ήχο, χωρίς αναφορά στη μελωδία (τουλάχιστον η μικρή σε μέγεθος ύδραυλη), ενώ το δεύτερο, από την ύπαρξη του ως τεχνολογικό επίτευγμα, που επιθυμεί να είναι αντικείμενο θαυμασμού.

3. Κεντρική Καλλιτεχνική Ιδέα και Ηχητικό Υλικό

Συνθετικά, η κεντρική ιδέα του έργου, στον χώρο παρουσίασης στο Μουσείο, ήταν η δημιουργία ενός ηχητικού περιβάλλοντος, που να προκαλεί την αντίληψη και τη μνήμη του ακροατή, ως προς δύο τύπους ήχων: α) τον ήχο του αέρα και β) τον ήχο του αυλού. Σε αυτό το πλαίσιο, το *Πνοή* χρησιμοποιεί δύο τύπους υλικού:

α) Την *ηχητική επιφάνεια*, όπου εφαρμόζεται ως *ήχος υποβάθρου* στο έργο, και σχετίζεται με την *ιστορική μνήμη του αέρα*

β) Τις *ηχητικότητες*, ως τύπους ηχητικών φασμάτων, κατασκευασμένες από τον ήχο φλάουτων και ύδραυλης και που χρησιμοποιούνται ως *ήχοι προσκηνίου*. Αυτές σχετίζονται με την *ιστορική μνήμη του ήχου του αυλού* και την εξέλιξή του στο χρόνο ως: απλός αυλός, πολυκάλαμος αυλός του Πάνα, ύδραυλης, εκκλησιαστικό όργανο, φλάουτο, ψηφιακό Όργανο.

Η ιδέα του υλικού ως *υπόβαθρο* και *προσκήνιο* προέρχεται από τον τομέα της ακουστικής οικολογίας, όπου οι ήχοι ενός ηχητικού τοπίου, μεταξύ άλλων, μπορούν να αναφέρονται ως ήχοι προσκηνίου και υποβάθρου (Ετμεκτσόγλου, 2014: 4).

4. Σύνθεση: Εννοιολογικά και Τεχνικά Χαρακτηριστικά

4.1. Ηχητική επιφάνεια: Η Ιστορία του ήχου του αέρα

Για τον πρώτο τύπο υλικού, το *Πνοή* χρησιμοποιεί τρεις μουσικές διαστάσεις του ήχου του αέρα, σύμφωνα με την αντίληψη μας για αυτό μέσα στην Ιστορία: α) τον μη ελεγχόμενο αέρα (σε αυτήν την περίπτωση, αέρας που σφυρίζει) με τον τρόπο που οι αρχαίοι τον αντιλαμβάνονται, ως στοιχείο που προκαλεί φόβο και ερμηνεύεται ως φάντασμα/πνεύμα, β) τον ελεγχόμενο αέρα, τον τρόπο που ο άνθρωπος τον αντιλαμβάνονταν μέχρι τον 20ο αιώνα, συμπεριλαμβανομένης της ελεγχόμενης χρήσης του μέσω οργάνων (όπως της ύδραυλης) και γ) τον προσομοιωμένο αέρα με ψηφιακά εργαλεία, από τον 20ο αιώνα και μετά με τη χρήση της τεχνολογίας.

Αυτή η ιδέα αντικατοπτρίζεται στη σύνθεση με πραγματικούς ήχους: Προηχογραφημένος ήχος αέρα, ψηφιακό όργανο (πνευστό σε πολύ χαμηλή συχνότητα, διότι σύμφωνα με τις εικονογραφικές παραστάσεις σε ψηφιδωτά δάπεδα, η ύδραυλη παιζόταν και σε συνδυασμό με σάλπιγγες στα αμφιθέατρα), και ψηφιακός αφηρημένος ήχος που μιμείται την κίνηση του αέρα. Αυτοί οι ήχοι εκτίθενται κάθετα (ταυτόχρονα) καθόλη τη διάρκεια του έργου και δημιουργούν έτσι μια ηχητική επιφάνεια που στο έργο λειτουργεί ως ήχος υποβάθρου.

4.2. Ηχητικότητα: Παρατηρήσεις ως προς τον Ήχο και την Κατασκευή της Ύδραυλης

Για τον δεύτερο τύπο υλικού, της *ηχητικότητας*, πριν προχωρήσω πρακτικά στην κατασκευή υλικών για τη σύνθεση, με βάση τα δεδομένα που είχα από τη Γεροφωκά, αλλά και την ακουστική εμπειρία από την παρουσίαση της ύδραυλης το 2016 στο Μουσείο της Ακρόπολης, έκανα πρώτα τις ακόλουθες τρεις παρατηρήσεις:

α) Ακούγοντας τον ήχο του ανακατασκευασμένου οργάνου, από την παρουσίαση στο Μουσείο Ακρόπολης ήταν προφανές ότι, ως προς το ηχόχρωμα/χροιά, η ύδραυλη δεν είναι εντελώς νέο όργανο, έχει μια αέρινη διάσταση/ποιότητα, παρόμοια με τον αυλό του Πάνα και κατ' επέκταση με το φλάουτο (ειδικά όταν παίζει *extended techniques*, π.χ. *aeolian sound*). Είναι ουσιαστικά μια πολυκάλαμη σύριγγα με πλήκτρα. Ωστόσο, θα μπορούσε να παίζει περισσότερους από έναν ήχους ταυτόχρονα (West, 2004:164). Ο Πολυδεύκης (*Ονομαστικόν*, 4. 70) αναφέρεται στην ύδραυλη ως, «πολύφωνος» και «ιταμώτερον». Αυτός ήταν ένας δεύτερος σημαντικός λόγος, για τον οποίο ήθελα να χρησιμοποιήσω υφές/ηχητικότητες και όχι μελωδίες.

β) Ενώ, έχει έναν σχετικά ισορροπημένο ήχο και πιο δυνατό, λόγω του υδραυλικού μηχανισμού, σε όλο το εύρος του οργάνου, (Καρασμάνης, 2005: 62), ως προς τη χροιά και τη δυναμική, μεταβάλλεται σε σχέση με το μέγεθος του οργάνου και των σωλήνων, (π.χ. μέγεθος δωματίου με μεγάλες σωλήνες) δημιουργώντας αμέτρητους ήχους και εκκωφαντικούς. Αλλά στην περίπτωση του Δίου, το όργανο είναι σχετικά μικρό, έτσι διατηρεί τα χαρακτηριστικά του ηδύ και τερπνού ήχου που αναφέρει ο Αθήναιος (*Δειπνοσοφισταί* 4. 75). Ωστόσο στο *Πνοή*, λαμβάνω υπ' όψη αυτό το εύρος χροιάς και δυναμικής λόγω των διαφορετικών μεγεθών της ύδραυλης και αρχίζω με βάση τον γλυκύ αέρινο ήχο, αλλά κατευθύνομαι ηχητικά προς ένα μεγαλοπρεπή ήχο, όμοιο του εκκλησιαστικού οργάνου. Αυτό σχετίζεται και με την επόμενη παρατήρηση.

γ) Η ύδραυλη είναι φυσικά το πρώτο όργανο με πλήκτρα, αλλά ουσιαστικά, περιλαμβάνει την πρώτη χρήση ενός μηχανισμού για την ενίσχυση και την εξισορρόπηση του ήχου ενός οργάνου, χωρίς την ανθρώπινη κινητική ενέργεια, κάτι που το τοποθετεί στην κορυφή των τεχνολογικών επιτευγμάτων της εποχής, τουλάχιστον σε σχέση με τη μουσική. Χαρακτηριστική είναι η αναφορά του Κλαύδιου Κλαυδιανού στον Πανηγυρικό του (*Panegyricus dictus Manlio Theodoro consuli*, 316-319) όπου αντιπαραβάλλει τον δυνατό ήχο της ύδραυλης με την ελαφρότητα του αγγίγματος του οργανοπαίχτη. Το ουσιαστικό εδώ είναι ότι πέραν του μουσικού πλαισίου, πρόκειται για ένα αντικείμενο θαυμασμού.

4.2.1. Ηχητικότητες: Συνθετικά Χαρακτηριστικά

Για τη δημιουργία ηχητικότητων συνθετικά, όπως προαναφέρθηκε, χρησιμοποίησα ήχους φλάουτων και ήχο ύδραυλης και δούλεψα ως προς το *ηχόχρωμα*, το *τονικό ύψος* και την *ένταση*.

4.2.1.1. Ηχόχρωμα και Τονικό Ύψος

Για τα φλάουτα, συνέθεσα ηχητικότητες, ως τύπους ηχητικών φασμάτων (μπορεί να το σκεφτεί κάποιος σαν σύνθετες συγχορδίες), που ηχογραφήθηκαν σε ένα οθωμανικό μουσείο στη Θεσσαλονίκη το Αλατζά Ιμαρέτ για διαφορετική περίπτωση, αλλά χρησιμοποιούνται εδώ σε διαφορετικό πλαίσιο. Το μνημείο έχει πολλή φυσική αντήχηση, κάτι που τονίζει ακόμα περισσότερο το αέρινο ηχόχρωμα του φλάουτου. Τα φλάουτα ερμηνεύουν τις ηχητικότητες με εκτεταμένες τεχνικές (*extended techniques*) που εστιάζουν περισσότερο στον αέρα, παρά το δοσμένο τονικό ύψος, πλησιάζοντας το ηχητικό χρώμα της ύδραυλης. Για τον ήχο της ύδραυλης, χρησιμοποίησα μικρά τμήματα μελωδίας της ανακατασκευασμένης ύδραυλης, δύο νοτών το πολύ, και τα συνδύασα με τις ηχητικότητες των φλάουτων. Έτσι δεν υπάρχει καμία αίσθηση μελωδίας ως προς αυτό.

Για το τονικό ύψος των ηχητικότητων, χρησιμοποίησα την ιδέα των κοσκίνων και της ηχητικότητας από τον Ιάκωβο Ξενάκη. Ένας λόγος που με έκανε να λειτουργήσω με αυτόν τον τρόπο είναι το κείμενο του Πορφυρίου Τύριου (233-303 μ.Χ.) που συνδέει τις αρχές της ακουστικής της οκτάβας για τον αυλό με την προσαρμογή σωλήνων στην ύδραυλη (Perrot, 1971: 55). Ως προς αυτό, έκανα μια προσωπική εφαρμογή (Εικόνα 1) της θεωρίας κοσκίνων του Ξενάκη, το οποίο βέβαια βασίζεται στο κόσκινο του Ερατοσθένη. Τα κόσκινα του Ερατοσθένη είναι γνωστά ως το πρώτο κόσκινο στα μαθηματικά και η χρήση του ήταν θεμελιώδης για τον Ξενάκη. Είχε δημιουργήσει μια μέθοδο φιλτραρίσματος στοιχείων δημιουργώντας και νέες κλίμακες με διαφορετική περιοδικότητα από αυτή της οκτάβας. Εδώ στο *Πνοή*, δεν χρησιμοποιούνται ως κλίμακες, αλλά ως κάθετες δομές (συγχορδίες), η καλύτερα ηχητικότητες. Με αυτό τον τρόπο, χρησιμοποιώντας κόσκινα,

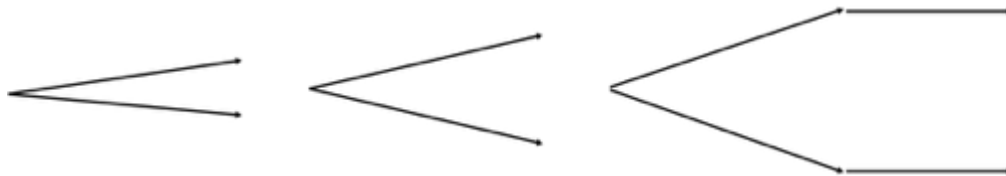
αποφεύγω κάθε συμβατικό άκουσμα που παραπέμπει σε αρχαίους τρόπους ή αρμονία, ενώ ταυτόχρονα είναι μια αναφορά στην αρχαιότητα.



Εικόνα 1.

4.2.1.2. Ένταση

Ως δομές, οι ηχητικότητες έχουν σχεδιαστεί με τη μορφή crescendo. Στη σύνθεση εμφανίζονται περιοδικά, με αυξημένη ένταση, προς μια κορυφή με μεγάλη διάρκεια, έναν εξισορροπημένο ήχο δηλαδή για ολόκληρη την ηχητικότητα, κάτι που παραπέμπει συμβολικά την εξέλιξη του αυλού προς τον εξισορροπημένο ήχο της ύδραυλης (Εικόνες 2 - 4).



Εικόνα 2. Ανάπτυξη ηχητικότητας ως προς την ένταση



Εικόνα 3. Τελευταία ηχητικότητα του έργου (βλέπουμε την αρχής της)



Εικόνα 4. Τελευταία ηχητικότητα του έργου (μέση και τέλος)

4.2.2. Ηχητικό Αποτέλεσμα

Όλα τα παραπάνω, δημιουργούν ένα ηχητικό αποτέλεσμα, κοντά στη σφαίρα του ηχητικού εφέ, που προσομοιώνει τον ήχο ενός σύγχρονου εκκλησιαστικού οργάνου. Με αυτόν τον τρόπο, το υλικό ανακεφαλαιώνει, λίγο πολύ, όλες τις εξελίξεις του αυλού.

4.3. Μίξη Ηχητικότητων και Ηχητικών επιφανειών

Αυτές οι ηχητικές δομές, ως ηχητικότητες τώρα, τοποθετούνται ως ήχος προσκηνίου πάνω από την ηχητική επιφάνεια που κατασκευάστηκε ως ήχος υποβάθρου και δημιουργούν το πλήρες ηχητικό έργο που εγκαταστάθηκε στο Μουσείο. Στην όλη φόρμα υπάρχει μια σχετική πλοκή, κυρίως ως προς την είσοδο και έξοδο ηχητικότητας σε σχέση με το σταθερό ηχητικό υπόβαθρο. Το έργο όμως είναι λιτό ως προς την ακρόαση και μετουσιώνει ιδέες/έννοιες, που προβάλλονται ακουστικά.

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Air and Sound: Historical Sound, Archaeological and Historical Data Transformed into Sound Art

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Abstract

The present text refers to the creation of a sound installation based on historical and archaeological data. The sound installation links air with the musical instrument hydraulis, which is displayed at the Museum of Dion, and uses air through a hydraulic mechanism to produce sound. The installation was incorporated into the latest theme of the educational program "Breaths of Winds: The Role of Air in Music," implemented in 2017 by the Ephorate of Antiquities of Pieria at the Archaeological Museum of Dion, within the framework of the Ministry of Culture's communication initiative "Environment and Culture".

The text is structured in two parts: In the first part, archaeologist Eleni Gerofoka focuses on the historical and archaeological evidence for ancient hydraulis. Specifically, she refers to ancient historical and literary sources, as well as archaeological findings such as iconographic representations on mosaic floors and remains of ancient instruments. In particular, the literary sources highlight the sound of the hydraulis and its acoustic dimension, allowing us to imagine how it might have sounded in different environments.

The second part presents the work of composer and sound artist Dimitris Bakas, in which historical and archaeological data are transformed into a sound Art. The artist employs principles of Acoustic Ecology and Ontology of Arts to create a sound installation aimed at awakening the listener's historical memory. In this context, the work, instead of examining the field of historical musical data, focuses on a more ambiguous area of interpretation: historical sound data. Specifically, by focusing on sound rather than melody, he observes the acoustic characteristics of the Hydraulis through recordings and attempts, through composition, to connect its sound with its historical context, highlighting the ontology of the instrument, its purpose, and its nature through a visual perspective.

Keywords

Hydraulis, hydraulic organ, sound art, historical sound

Τα ηχοτοπία της Κέας ως ηχητικό υπόβαθρο για την καταγραφή και ανάδειξη παραδοσιακών οργανοπαιχτών

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Περίληψη

Στην παρούσα ερευνητική εργασία παρουσιάζεται η μεθοδολογία που ακολουθήθηκε για την καταγραφή των παραδοσιακών οργανοπαιχτών της Κέας με σκοπό τη διάσωση, διατήρηση και ανάδειξη της παραδοσιακής μουσικής ως στοιχείο της άυλης πολιτιστικής κληρονομιάς. Το έργο περιλάμβανε τη δημιουργία δέκα αυτοτελών ντοκιμαντέρ, στα οποία καταγράφονται οι εναπομείναντες ηλικιωμένοι οργανοπαίχτες του νησιού, καθώς και τα παιδιά ή/και εγγόνια των σημαντικότερων παραδοσιακών μουσικών της Κέας. Στη συγκεκριμένη δημοσίευση αρχικά παρουσιάζονται οι στόχοι και η πρωτοτυπία του έργου, ενώ δίνεται έμφαση στη μεθοδολογία καταγραφής των ηχοτοπίων, των διαλόγων και των παραδοσιακών μουσικών *in situ* με τη χρήση υψηλής ποιότητας ηχητικού εξοπλισμού. Επιπλέον, εξετάζεται η μέθοδος κινηματογράφησης των παραδοσιακών μουσικών στα χαρακτηριστικά τοπία που επιλέχθηκαν και περιγράφεται πως η χρήση εναέριων πλάνων από *drone* προσδιορίζει τα τοπία και αναδεικνύει τη γεωγραφική και πολιτιστική ιδιαιτερότητά τους. Ειδική αναφορά γίνεται στη σύνθεση της μουσικής που πλαισιώνει τους τίτλους των ντοκιμαντέρ, η οποία δημιουργήθηκε με την εξολοκλήρου χρήση δειγμάτων από το δεξιοτεχνικό παίξιμο ηλικιωμένων παραδοσιακών μουσικών. Ακολούθως, επεξηγείται η διαδικασία επεξεργασίας του ηχητικού και κινηματογραφικού υλικού καθώς και ο τρόπος παραγωγής των ντοκιμαντέρ. Επιπροσθέτως, πραγματοποιείται εθνομουσικολογική τεκμηρίωση των τραγουδιών και σκοπών που ερμήνευσαν οι μουσικοί, παρουσιάζεται η διαφοροποίηση της ερμηνείας τους ανάλογα με την περιοχή καταγωγής τους, και ερευνάται κατά πόσο η ερμηνεία των μουσικών επηρεάζεται από τις χωροχρονικές συνθήκες του ηχοτοπίου. Τέλος, περιγράφονται η απήχηση και η διάχυση των ντοκιμαντέρ.

Λέξεις Κλειδιά

Ηχοτοπία, καταγραφή πεδίου, ντοκιμαντέρ, παραδοσιακοί οργανοπαίχτες, τσαμπούνα, τουμπί, Κέα

1. Εισαγωγή

Το νησί της Κέας έχει συμβάλει στην παραδοσιακή μουσική της Ελλάδας, προσφέροντας εξαιρετικούς οργανοπαίχτες και μουσικούς, οι οποίοι έχουν επηρεαστεί τόσο από τη θαλασσινή όσο και από τη στεριανή μουσική παράδοση. Οι παραδοσιακοί οργανοπαίχτες της Κέας έχουν αναπτύξει ιδιαίτερα δεξιοτεχνικό παίξιμο με πολλές τοπικές ιδιαιτερότητες και μουσικά ιδιώματα. Χαρακτηριστικό μουσικό όργανο της παραδοσιακής μουσικής του νησιού είναι η τσαμπούνα, παραδοσιακό πνευστό, η οποία ανήκει στην κατηγορία των άσκαυλων

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(εν προκειμένω άσκαυλος της νησιωτικής Ελλάδας) και η οποία συνοδεύεται ως ζυγιά (ζευγάρι) από το *τουμπί* (παραδοσιακό χειροποίητο κρουστό), ενώ είθισται να παλαισιώνεται και από βιολί και λαούτο.

Τη συγκεκριμένη δράση με τίτλο: «Καταγραφή παραδοσιακών οργανοπαιχτών της Κέας για τη διάσωση, διατήρηση και ανάδειξη της παραδοσιακής μουσικής ως άυλης πολιτιστικής κληρονομιάς» υλοποίησε η Κοινωφελής Επιχείρηση του Δήμου Κέας, χρηματοδοτούμενη από το μουσείο Κυκλαδικής Τέχνης μέσω του προγράμματος *Cycladic Identity*. Περιλάμβανε τη δημιουργία δέκα αυτοτελών ντοκιμαντέρ με τους εναπομείναντες ηλικιωμένους οργανοπαίχτες του νησιού, καθώς και των παιδιών ή/και εγγονιών των σημαντικότερων παραδοσιακών μουσικών της Κέας.

Στα ντοκιμαντέρ πραγματοποιήθηκε επίδειξη του δεξιοτεχνικού παιξίματος των παραδοσιακών μουσικών και ατομικές συνεντεύξεις, ενώ καταγράφηκαν οι τρόποι ερμηνείας συγκεκριμένων τραγουδιών και εξιστόρηση παλαιών ιστοριών από γιορτές και πανηγύρια. Τα αυτοτελή ντοκιμαντέρ αποτελούνται από το ίδιο σκηνοθετικό πλαίσιο, έχουν ίδιες ενότητες και μεθοδολογική προσέγγιση, συγκεκριμένες ερωτήσεις, παρόμοια δομή κ.λπ. Βασική επιδίωξη ήταν τα σημαντικότερα μέρη από το κάθε ντοκιμαντέρ να ενσωματωθούν σε ένα ενιαίο μεγάλης χρονικής διάρκειας αρθρωτό ντοκιμαντέρ, που να περιλαμβάνει όλους τους δεξιοτέχνες παραδοσιακούς μουσικούς.

2. Στόχος και πρωτοτυπία του έργου

Για τη δράση αυτή θεωρήθηκε σημαντική η καταγραφή των μουσικών μέσα στο ηχοτοπίο (*in situ*), και όχι απομονωμένων όπως θα γινόταν σε κάποιο στούντιο ηχογράφησης. Η παρουσία του φυσικού περιβάλλοντος του νησιού αναδύει το τοπόσημο και το περιβάλλον του, το οποίο συνεισφέρει και αυτό στο βασικό σκοπό της δράσης: στην καταγραφή, στη διάσωση και στην ανάδειξη των μουσικών και των παραδόσεων τους, καθώς και εν τέλει στην προβολή του ίδιου του νησιού. Οι καταγραφές των ηχοτοπίων προσέδωσαν υψηλή προστιθέμενη αξία στο πλαίσιο μιας συνολικότερης και ολιστικότερης καταγραφής, καθώς ανέδειξαν τις σχέσεις αλληλεπίδρασης των μουσικών με το ηχητικό τους περιβάλλον και την ισορροπία της σχέσης αυτής. Η συγκεκριμένη προσέγγιση συμβάλλει στην ολιστική αποτύπωση του πολιτιστικού και φυσικού περιβάλλοντος της Κέας, προσφέροντας μια πολυαισθητηριακή εμπειρία που ενισχύει την κατανόηση και την εκτίμηση της τοπικής πολιτιστικής κληρονομιάς.

Η πρωτοτυπία του προγράμματος ήταν μεγάλη καθώς δεν είχε γίνει ξανά αντίστοιχη δράση σε νησί των Κυκλάδων. Η χρήση των αρχών και της μεθοδολογικής προσέγγισης της ακουστικής οικολογίας πρόσφερε το εχέγγυο για υψηλής ποιότητας και πιστότητας ηχητικές και κινηματογραφικές καταγραφές. Κατά τη διαδικασία της κινηματογραφικής επεξεργασίας και τελικής διαμόρφωσης των ντοκιμαντέρ, τα ηχοτοπία μαζί με τους ήχους από τα έμβια όντα που ηχογραφήθηκαν εντάχθηκαν δημιουργικά βοηθώντας την οπτικοηχητική αφήγηση. Βασική επιδίωξη της συγκεκριμένης δράσης ήταν μαζί με τους δεξιοτέχνες μουσικούς να καταγραφεί και το ηχοτοπίο της εκάστοτε περιοχής, δηλαδή οι ήχοι που αναδύονται από το κάθε περιβάλλον. Η συγκεκριμένη προσέγγιση, η επιλογή δηλαδή της ερμηνείας από τους δεξιοτέχνες μουσικούς μέσα σε χαρακτηριστικά τοπόσημα της Κέας, με την ταυτόχρονη καταγραφή του φυσικού ηχοτοπίου, το οποίο εντάχθηκε μέσα στα ντοκιμαντέρ ως ηχητικό υπόβαθρο, αποτέλεσε ένα από τα βασικά χαρακτηριστικά πρωτοτυπίας του συγκεκριμένου προγράμματος.

3. Μεθοδολογία

Η μεθοδολογία που ακολουθήθηκε στη δημιουργία των δέκα αυτοτελών ντοκιμαντέρ ήταν κοινή σε όλα τα στάδια (καταγραφή, επεξεργασία, μεταπαραγωγή). Όλες οι καταγραφές πραγματοποιήθηκαν στην Κέα σε δυο χρονικές περιόδους: στις 15.06.2023 με 19.06.2023 και στις 27.07.2023 με 31.07.2023. Η επιλογή των σημείων που πραγματοποιήθηκαν οι συνεντεύξεις και οι μουσικές ηχογραφήσεις έγινε με γνώμονα να αποτελούν χαρακτηριστικά τοπόσημα της περιοχής, να αναδεικνύουν το φυσικό κυκλαδίτικο περιβάλλον τόσο οπτικά όσο και ηχητικά, έχοντας πλούσια ηχοποικιλότητα και να έχουν συμβάλει ως μέρη στην τοπική πολιτισμική κληρονομιά. Τα τοπόσημα που επιλέχθηκαν (Εικόνα 1) ήταν η Ιερά Μονή Καστριανής, ο Άγιος Συμεών, αυλές σπιτιών στην Ιουλίδα αλλά και σε φυσικά περιβάλλοντα όπως η Βρύση του Βενιαμίν, η παραλία στις Πίσσες, ο Ιερός Ναός της Αγίας Ειρήνης στο Βουρκάρι κ.α.

3.1. Διαδικασία ηχητικής καταγραφής



Εικόνα 1. Στιγμιότυπα από τα ντοκιμαντέρ με τους μουσικούς στα τοπία που επιλέχθηκαν

3.1.1. Διαδικασία καταγραφής διαλόγων

Για την καταγραφή των διαλόγων και των συνεντεύξεων χρησιμοποιήθηκε εξοπλισμός υψηλής πιστότητας για τη βέλτιστη ηχητική απόδοση σε εξωτερικούς χώρους. Συγκεκριμένα, επιλέχθηκε ένα κατευθυντικό μικρόφωνο τύπου shotgun (AKG c 568) για την καταγραφή του κύριου ήχου, το οποίο εξασφάλισε απόρριψη των πλευρικών θορύβων σε μεγάλο βαθμό, καθώς και ακριβή εστίαση στην πηγή του ήχου. Επίσης για την καταγραφή διαλόγων, εφαρμόστηκαν ασύρματα μικρόφωνα τύπου πέτου (lavalier) στους συνεντευξαζόμενους. Η καταγραφή πραγματοποιήθηκε με το φορητό καταγραφικό Sound Devices MixPre-6, το οποίο είναι εφοδιασμένο με προενισχυτές υψηλής ποιότητας και προσφέρει τη δυνατότητα πολυканάλιας εγγραφής.

Η επιλογή του συνδυαστικού αυτού εξοπλισμού είχε ως κύριο στόχο την εστιασμένη λήψη και την απομόνωση των διαλόγων από τους περιβαλλοντικούς ήχους. Με τον τρόπο αυτό διευκολύνθηκε η διαδικασία της μεταπαραγωγής και μειώθηκε σημαντικά ο χρόνος επεξεργασίας του ήχου. Επιπλέον, η μεθοδολογική αυτή προσέγγιση συνέβαλε στον ακριβή έλεγχο της ισορροπίας μεταξύ των διαλόγων και των ηχοτοπίων κατά τη διαδικασία της μίξης, και ως εκ τούτου στην ανάδειξη τόσο των προφορικών μαρτυριών όσο και των χαρακτηριστικών ήχων κάθε τοποθεσίας. Η κύρια δυσκολία κατά τη διαδικασία της ηχογράφησης των διαλόγων στο φυσικό περιβάλλον ήταν οι γεωγραφικές ιδιαιτερότητες των τοποσήμων, οι οποίες είχαν ως αποτέλεσμα έντονους άνεμους στις περισσότερες καταγραφές. Για την αντιμετώπιση των ριπών του ανέμου εφαρμόστηκε σε όλες τις ηχογραφήσεις κατάλληλη αντιανεμική προστασία (windshields και blimps).

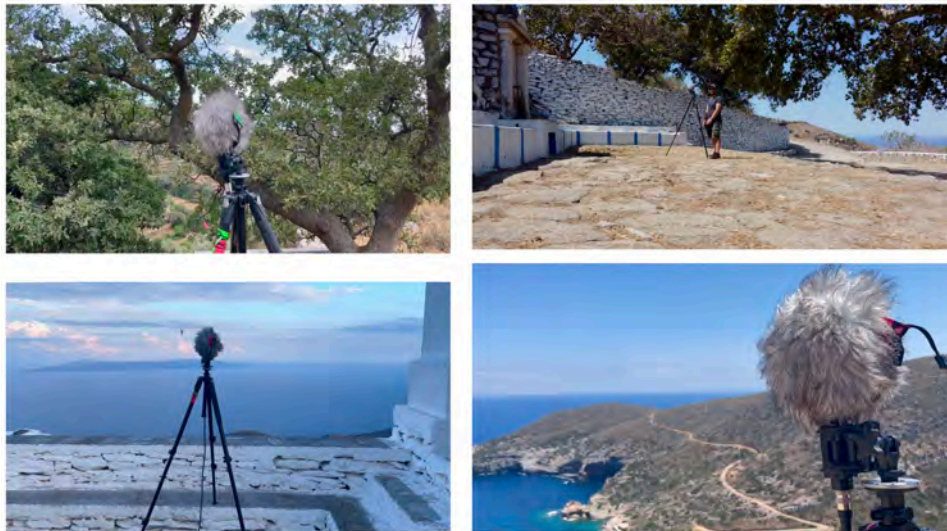
3.1.2. Διαδικασία καταγραφής μουσικών οργάνων

Για την καταγραφή των μουσικών οργάνων σε συνθήκες *in situ*, επιλέχθηκαν δύο πυκνωτικά μικρόφωνα μικρού διαφράγματος με καρδιοειδές πολικό διάγραμμα (Line Audio CM3). Κύριος στόχος ήταν η ηχογράφηση κάθε μουσικού οργάνου να πραγματοποιηθεί όσο το δυνατόν ηχητικά απομονωμένο από τα υπόλοιπα όργανα της ζυγιάς, προκειμένου να εφαρμοσθούν διαφορετικές επεξεργασίες κατά τη μεταπαραγωγή. Η χρήση μόνο δύο μικροφώνων (ένα για την τσαμπούνα και ένα για τη φωνή και ταυτόχρονα το τουμπί) κρίθηκε απαραίτητη για τη διασφάλιση εύκολης διαχείρισης των σημάτων στο πεδίο. Καθώς το τουμπί συνοδευόταν από φωνητικά, τοποθετήθηκε κατάλληλα το μικρόφωνο για την εξισορρόπηση της έντασης μεταξύ φωνής και τουμπιού. Σε

αρκετές περιπτώσεις, ο ηχολήπτης προέβη σε παρεμβάσεις κατά την εκτέλεση, ζητώντας διαφοροποιήσεις στις δυναμικές ισορροπίες των οργάνων, ώστε να διευκολυνθεί η καταγραφή. Για βέλτιστη ηχογράφιση τα μικρόφωνα τοποθετήθηκαν συχνά εντός των κινηματογραφικών πλάνων. Επιπλέον, και τα δύο μικρόφωνα έφεραν αντιανεμική προστασία για την αποτροπή παρεμβολής από τον αέρα.

3.1.3. Διαδικασία καταγραφής ηχοτοπίων

Για την καταγραφή των ηχοτοπίων στα επιλεγμένα τοπία επιλέχθηκε η μέθοδος ambisonics, διότι παρέχει τη δυνατότητα ηχογράφησης του ηχοτοπίου τρισδιάστατα (surround 360°), καθώς και επιλογή του φορμά αναπαραγωγής κατά το στάδιο της μεταπαραγωγής (από μονοφωνικό, stereo, μέχρι 5.1 και binaural) (Malham, & Myatt, 1995). Το μικρόφωνο που επιλέχθηκε ήταν το Ambeo VR Mic της Sennheiser, ένα ευέλικτο μικροφωνικό σύστημα που αποτελείται από τέσσερις διακριτές καρδιοειδείς κάψες σε τετραεδρική διάταξη, ενσωματωμένες σε ένα ενιαίο συμπαγές σώμα. Όλες οι καταγραφές έγιναν πριν ή μετά την ολοκλήρωση των κινηματογραφίσεων των ντοκιμαντέρ και αφού είχε επανέλθει η ηχητική ισορροπία στο πεδίο. Πριν από την κάθε καταγραφή του ηχοτοπίου, πραγματοποιήθηκε ενδελεχής ακρόαση για τον εντοπισμό θέσεων που να αναδεικνύουν την ηχοποικιλότητα και τη βιοποικιλότητα, και την αποφυγή, όσο ήταν εφικτό, των ανθρωπογενών θορύβων. Οι επιμέρους θέσεις για τις καταγραφές επιλέχθηκαν διατηρώντας μια ισορροπία μεταξύ βιολογικής και γεωφυσικής προέλευσης των ήχων, ώστε να μην απαιτηθεί στο στάδιο της μεταπαραγωγής ενδελεχής επέμβαση. Όλες οι καταγραφές των ηχοτοπίων και των μουσικών πραγματοποιήθηκαν με το φορητό καταγραφικό Sound Devices MixPre-6.



Εικόνα 2. Διαδικασία καταγραφής των ηχοτοπίων

3.2. Διαδικασία κινηματογράφησης

Για τις ανάγκες του έργου χρησιμοποιήθηκαν σε όλα τα αυτοτελή ντοκιμαντέρ τρεις κάμερες, δυο Panasonic³⁸ με διαφορετικούς φακούς και μια κάμερα δράσης Go Pro. Επιλέχθηκε ένας φακός (12-35 MM) για το γενικό πλάνο (καδράρισμα) στο οποίο φαίνεται ο/οι υπό κινηματογράφιση παραδοσιακός/οι μουσικός/οι μαζί με τον περιβάλλοντα χώρο, και ένας φακός (14 MM) για μεσαία και κοντινά πλάνα, τα οποία ήταν χρήσιμα κατά την επίδειξη του μουσικού οργάνου (π.χ. μέρη τσαμπούνας ή τουμπιού) ή για την αποτύπωση του δεξιτεχνικού τρόπου παιξίματος. Επιλέχθηκαν κατά την κινηματογράφιση των μουσικών κυρίως μεσαία και μακρινά πλάνα (αποφυγή των πολύ κοντινών), έτσι ώστε να περιέχουν περισσότερες πληροφορίες του εκάστοτε τοπίου και σε συνδυασμό με την ηχογράφιση του ηχοτοπίου να προσδώσουν ένα εντυπωσιακό αποτέλεσμα.

Στα τοπία που είχαν προσδιοριστεί για τις κινηματογραφήσεις των δεξιτεχνών μουσικών, επιλέχθηκαν σημεία ώστε κατά τη στατική κινηματογράφιση να μην βρίσκονται κόντρα στον ήλιο, με στόχο να επιτευχθεί η μέγιστη δυνατή ευκρίνεια. Επειδή η κινηματογράφιση υπό το άμεσο ηλιακό φως συχνά δημιουργεί «άτσαλες» σκιές και υπερβολική αντίθεση προτιμήθηκε πιο «ηπιό» φως, και για τον λόγο αυτό οι καλοκαιρινές κυρίως βιντεοσκοπήσεις πραγματοποιήθηκαν νωρίς το πρωί ή αργά το απόγευμα. Επίσης, η χρήση ενός σταθεροποιητή

³⁸ Panasonic Mirrorless Φωτογραφική Μηχανή Lumix GH5 Micro Four Thirds

κάμερας βοήθησε στη δημιουργία ελαφρώς κινουμένων πλάνων, βοηθώντας την αφήγηση των οργανοπαιχτών και προσδίδοντας την αίσθηση της ροής/κίνησης.

Για την πληρέστερη αποτύπωση του νησιωτικού τοπίου και την ανάδειξη της γεωγραφικής του ιδιαιτερότητας, πραγματοποιήθηκαν εναέριες λήψεις με χρήση drone σε υψηλή ανάλυση και μέγιστο βάθος πεδίου, εξασφαλίζοντας εξαιρετική ευκρίνεια και λεπτομέρειες στο τελικό υλικό (Εικόνα 3). Οι κάθετες λήψεις (top-down) χρησιμοποιήθηκαν στρατηγικά για να προσδιορίσουν τη γεωγραφική θέση και να αναδείξουν τη χωροταξική σχέση των τοποσημών με τον περιβάλλοντα χώρο. Η εκτέλεση αργών πανοραμικών κινήσεων 360 μοιρών από διαφορετικά υψόμετρα επέτρεψε την ολιστική καταγραφή του τοπίου, αποκαλύπτοντας τη μορφολογία του εδάφους και τη γεωγραφική σχέση στεριάς-θάλασσας. Χρησιμοποιήθηκαν επίσης σύνθετες κινήσεις όπως σταδιακή αποκάλυψη του τοπίου (reveal) και κυκλική περιστροφή γύρω από σημεία ενδιαφέροντος (orbit) προσφέροντας δυναμικές οπτικές αφηγήσεις. Για την ανάδειξη της μορφολογίας του τοπίου, εκτελέστηκαν λήψεις με σταδιακή μετάβαση από χαμηλό σε υψηλό υψόμετρο (lift shots), ενώ οι πλάγιες διαδρομές (sideways tracking) χρησιμοποιήθηκαν για να αναδείξουν το ανάγλυφο της ακτογραμμής και των ορεινών όγκων. Ιδιαίτερη έμφαση δόθηκε στην καταγραφή κατά τις ώρες του χρυσού φωτός (golden hour)³⁹, όπου οι μακριές σκιές και οι θερμοί τόνοι του φωτός προσέδωσαν επιπλέον ενδιαφέρον στις λήψεις.

Συνολικά, η συνδυαστική χρήση των στατικών κινηματογραφήσεων με αυτών των τεχνικών εναέριας κινηματογράφησης συνέβαλε καθοριστικά στη δημιουργία ενός οπτικού αφηγήματος που αναδεικνύει τόσο τη φυσική ομορφιά όσο και την περιβαλλοντική αξία των τοποθεσιών.



Εικόνα 3. Εναέρια στιγμιότυπα από τις κινηματογραφήσεις των τοπόσημων με drone

3.3. Δημιουργία Μουσικής

Η μουσική των τίτλων ακούγεται στην αρχή και το τέλος του κάθε αυτοτελούς ντοκιμαντέρ και εισαγάγει ηχητικά-μουσικά τον θεατή στον κόσμο της μουσικής παράδοσης της Κέας, δημιουργώντας μια ιδιαίτερη ηχητική ατμόσφαιρα εμπύθισης στο κινηματογραφικό περιεχόμενο, και σηματοδοτώντας την εναλλαγή των ενοτήτων. Η σύνθεση της μουσικής αποτέλεσε μια αισθητική πρόκληση, καθώς ο ρόλος της είναι αφενός να δημιουργεί κινηματογραφική αίσθηση, και αφετέρου να διατηρεί την παραδοσιακή στυλιστική μουσική χροιά. Αποφασίστηκε λοιπόν να δημιουργηθεί μια θεματική σύνθεση με ήχους δανεισμένους αποκλειστικά από τα παραδοσιακά όργανα που ηχογραφήθηκαν, τόσο ως προς τα παραδοσιακά μουσικά μοτίβα-μελωδίες, όσο και ως προς τα παρα-μουσικά στοιχεία (paralinguistics) (Λουφόπουλος, 2008).

Κυρίαρχο μουσικό στοιχείο στην εισαγωγή του κάθε ντοκιμαντέρ αποτελεί ο ήχος της τσαμπούνας, η οποία ακούγεται να παίζει αυτοσχεδιαστικά στο παραδοσιακό ύφος της μουσικής της Κέας, δείγμα δανεισμένο από το περιεχόμενο των ηχογραφήσεων που έγιναν στο πλαίσιο των ντοκιμαντέρ. Το μουσικό αυτό θέμα πλαισιώνεται από κρότους που παρήχθησαν από το τουμπί (επεξεργασμένα δείγματα μικρής διάρκειας) και

³⁹ Βλ. Αιμίλιος Λαγκώνης διαθέσιμο στο: <https://cutt.ly/JeF6BoH2>

θορύβους/κυματισμούς που προέρχονται από τον ήχο της αναπνοής, αλλά και του «αέρα» καθώς ο τσαμπουνιέρης φυσάει για να φουσκώσει την τσαμπούνα.

Για να αποδοθεί η κινηματογραφική/ατμοσφαιρική αίσθηση, ο ήχος της τσαμπούνας υπέστη ηλεκτρονική επεξεργασία, δημιουργώντας έναν τονικό ισοκράτη, ένα τονικό κέντρο που χρησιμοποιείται ως υπόβαθρο. Ο ισοκράτης δημιουργήθηκε μέσω της τεχνικής της χρονικής αλλοίωσης (time stretching) πάνω σε ένα σύντομο μονοτονικό ηχητικό δείγμα της τσαμπούνας. Οι «κυματισμοί» παρήχθησαν με τον ίδιο τρόπο, μέσω χρονικής αλλοίωσης δειγμάτων θορύβου που παράγονται από το όργανο και τον εκτελεστή (φύσημα, αναπνοή), ενώ οι ήχοι κρούσης (impacts) από πολλαπλασιασμό ενός δείγματος από το τουμπί και μίξη του σε πολλαπλές τονικότητες και με παραλλαγές ως προς την ηχητική ισοστάθμιση (EQ) του. Η προσθήκη αντήχησης (reverb) προσέδωσε τον κατάλληλο «χώρο» στη σύνθεση. Ως προς τους τίτλους τέλους, χαρακτηριστικό στοιχείο αποτελεί ο ρυθμός, ο οποίος δημιουργήθηκε από ένα δείγμα ενός ολόκληρου μουσικού μέτρου από το τουμπί, το οποίο πολλαπλασιάστηκε χρονικά σε λούπα. Ο ήχος υπέστη επίσης τονική επεξεργασία, δημιουργώντας ένα πιο «βαθύ» χτύπημα (τονική παραλλαγή του δείγματος μέσω τεχνικής pitch shifting) το οποίο ακούγεται σε μίξη με το αρχικό στην αρχή κάθε μουσικού μέτρου αλλά και ενδιάμεσα, με στόχο την ενίσχυση της κινηματογραφικής αισθητικής και του επικού στοιχείου. Στους τίτλους τέλους ακούγεται επίσης ο ηλεκτρονικός ισοκράτης που συναντάμε στην εισαγωγή και ο αυτοσχεδιασμός της τσαμπούνας σε διαφορετικές παραλλαγές.

Τα δείγματα για τη σύνθεση της μουσικής ήταν από τους ηλικιωμένους Μηνά Πατινιώτη⁴⁰ και Παπα-Λευτέρη Δεμένεγα⁴¹, ηχογραφημένα στην Ιερά Μονή Καστριανής. Για την επεξεργασία και μίξη της σύνθεσης χρησιμοποιήθηκε το λογισμικό Apple LogicProX, καθώς και το λογισμικό PaulXstretch.

4. Παραγωγή των ντοκιμαντέρ

Στο στάδιο της παραγωγής και μεταπαραγωγής των ντοκιμαντέρ (post-production), ακολουθήθηκε το ίδιο σκηνοθετικό πλαίσιο, το οποίο υπηρέτούσε τον στόχο που είχε τεθεί εξ αρχής, δηλαδή τη δημιουργία αυτοτελών ντοκιμαντέρ με παρόμοια δομή, ίδιες ενότητες, συγκεκριμένες ερωτήσεις κ.λπ., των οποίων επιλεγμένα μέρη δύναται να ενσωματωθούν σε ένα ενιαίο, μεγάλης χρονικής διάρκειας αρθρωτό ντοκιμαντέρ, που θα περιλαμβάνει όλους τους δεξιότεχνες παραδοσιακούς μουσικούς.

Κάθε ντοκιμαντέρ αρχίζει με τη μουσική των τίτλων και τους τίτλους αρχής. Στο τέλος των τίτλων, σε μαύρο φόντο εισάγεται το ηχοτοπίο με αργό fade-in εστιάζοντας την προσοχή του θεατή. Το ηχοτοπίο παραμένει ως υπόβαθρο καθ' όλη τη διάρκεια του ντοκιμαντέρ. Στη συνέχεια, εμφανίζεται ένα εναέριο πλάνο από drone, το οποίο προσδιορίζει το τοποσχημό και αναδεικνύει τη γεωγραφική και πολιτιστική του ιδιαιτερότητα. Ακολουθεί η εισαγωγή του συνεντευξιαζόμενου, ο οποίος παρουσιάζεται και απαντά σε ερωτήσεις, ενώ στη συνέχεια κάνει επίδειξη του μουσικού του οργάνου και, εν τέλει, ερμηνεύει ένα ή δύο τραγούδια. Στο τέλος προβάλλονται οι τίτλοι τέλους. Η συνέντευξη δομείται σε διακριτές ενότητες, οι οποίες χωρίζονται μέσω των χαρακτηριστικών μουσικών μοτίβων που δημιουργήθηκαν ειδικά για το σκοπό αυτό. Τα στατικά πλάνα από τις κάμερες εμπλουτίζονται με εναέρια πλάνα της ευρύτερης περιοχής, ενώ φωνήματα πουλιών και άλλων έμβιων όντων εμφανίζονται διακριτικά.

Η ηχητική επεξεργασία που εφαρμόστηκε στα μικρόφωνα των συνεντευξιαζόμενων και στα ηχοτοπία ήταν τυπική, ενώ για τη μουσική απαιτήθηκε πιο δραστητική επεξεργασία. Ιδιαίτερη προσοχή δόθηκε στη διαδικασία της μίξης για τη διάκριση των ηχητικών επιπέδων (layers) σε όλη τη διάρκεια του ντοκιμαντέρ. Η επεξεργασία της εικόνας επικεντρώθηκε στην επίτευξη ευκρίνειας και στην ακριβή απόδοση των χρωμάτων για κάθε τοποσχημό, καθώς και στην αποτύπωση των χρωματικών διαφορών μεταξύ των διαφορετικών περιόδων καταγραφής.

5. Εθνομουσικολογική τεκμηρίωση των τραγουδιών

Η μουσική της Κέας φέρει όλα τα χαρακτηριστικά της νησιώτικης παραδοσιακής μουσικής, παιγμένης με την παραδοσιακή ζυγιά τσαμπούνα - τουμπί, όπου ο άσκαυλος παίζει τη μελωδία του τραγουδιού και το τουμπί συνοδεύει ρυθμικά, ενώ ο τουμπιέρης τραγουδάει. Ένα άλλο -ευρύτερο- μουσικό σύνολο (τα τελευταία χρόνια) είναι: βιολί, τσαμπούνα, λαούτο, τουμπί (ή και 2-4 τουμπιά μαζί. Παράδειγμα ηχογράφησης του κ. Ξέστερνου⁴²

⁴⁰ Βλ. Μηνάς Πατινιώτης διαθέσιμο στο: <https://cutt.ly/seF4INp8>

⁴¹ Βλ. Παπα-Λευτέρης Δεμένεγας διαθέσιμο στο: <https://cutt.ly/ZeF4IglF>

⁴² Βλ. Λευτέρης Ξέστερνος διαθέσιμο στο: <https://cutt.ly/8eF6JvCa>

με δύο τουμπιά και του κ. Κοζαδίνου⁴³ επίσης με δύο τουμπιά). Τα μουσικά όργανα αυτά, όπως σε κάθε παραδοσιακή συμβιωτική κοινότητα, έτσι και στο νησί της Κέας, παλαιότερα κατασκευάζονταν από τον ίδιο τον οργανοπαίκτη, γεγονός που τα καθιστούσε μοναδικά, προσωποποιημένα και «δεν τα έδιναν σε άλλον», όπως χαρακτηριστικά αναφέρει ο Παπα-Λευτέρης Δεμένεγας⁴⁴ και ο Νίκος Κορασίδης⁴⁵. Ο κάθε μουσικός είχε τον δικό του τρόπο επιτέλεσης και μια μοναδική σχέση με το μουσικό του όργανο, από την οποία εξαρτιόταν ο τρόπος και το ύφος ερμηνείας του, όπως και η ακουστική του οργάνου. «Φυσάει τα βάσανά του και βγάνει μουσική» είναι η χαρακτηριστική φράση του πληροφορητή Παπα-Λευτέρη Δεμένεγα για την ψυχή που βάζει ο τσαμπουνιέρης για να δημιουργήσει μουσική. Σε σύγκριση με τις παλαιότερες γενιές που «έκλεβαν» το παίξιμο των μεγαλύτερων στους γάμους και τα πανηγύρια και μάθαιναν βιωματικά και «με το αυτί», οι νέες γενιές έχουν την τύχη να διδάσκονται την παραδοσιακή μουσική και τα μυστικά της από τους μεγαλύτερους, με τη διαφορά ότι πλέον το ρεπερτόριο είναι ομογενοποιημένο. Η μετάβαση από την αγροτική στην αστικοποιημένη κοινωνία, έτσι όπως αυτή εκδηλώθηκε με την εμφάνιση και επικράτηση πιο «αστικών» οργάνων όπως το βιολί και το λαούτο, είχε αντίκτυπο και στο μουσικό ρεπερτόριο, ενώ οδήγησε ταυτόχρονα στην «ισοπέδωση» του τοπικού μουσικού ιδιώματος.

Η λαϊκή μουσική έκφραση του νησιού της Κέας ανήκει σε μια ενιαία καλλιτεχνική και πολιτισμική ταυτότητα των Κυκλάδων, φυσικά με τις τοπικές παραλλαγές της - ως άυλη πολιτισμική κληρονομιά. Έτσι, παρατηρούνται διαφορές από περιοχή σε περιοχή (π.χ. Πίσσες, Κορησσία, Ιουλίδα, Σπαθί, Κάτω Μεριά) σε ό,τι αφορά το μουσικό ιδίωμα, τον τρόπο παιξίματος, το χρώμα, ακόμη και την ταχύτητα (ρυθμική αγωγή) ερμηνείας του τοπικού ρεπερτορίου, το οποίο περιλαμβάνει τετράσημους συρτούς χορούς, δίσημους μπάλους και γρήγορες εξελληνισμένες πόλκες με κλειστή λαβή στα χέρια, χωρίς να λείπουν και ειδικά τραγούδια: αποκριάτικα, κάλαντα κ.λπ. Από τη μαρτυρία του Παπα-Λευτέρη Δεμένεγα, πρωτεργάτη της διατήρησης και διδασκαλίας της παραδοσιακής μουσικής στην Κέα, κατανοούμε ότι όσο πιο μακριά από το αστικό τοπίο είναι ο μουσικός/ τσαμπουνιέρης, τόσο πιο αργό, «μερακλίδικο» είναι το παίξιμό του, ενώ όσο πιο κοντά στη χώρα (Ιουλίδα) γίνεται το γλέντι, τόσο πιο γρήγορα παίζει ο τσαμπουνιέρης (οι ντόπιοι το λένε «διπλοδοχατυλιά»), υποκλύποντας σε όρους «δεξιολογίας» που συνδέονται με ευρύτερους οικονομικούς ή/ και τουριστικούς σκοπούς για την απόκτηση καλύτερης «χαρτούρας» (περισσότερα λεφτά) από τον χορευτή. Από το παίξιμο του κ. Νίκου Βουτυρά⁴⁶ στο λαούτο, παρότι τον ακούμε να παίζει ένα παραδοσιακότροπο τραγούδι που εμπνεύστηκε ο ίδιος («Ένας Καπετάνιος»), προδίδεται η κλασική του παιδεία στην κιθάρα, καθιστώντας την έντεχνη ερμηνεία -με τις αρμονικές συνηχήσεις και τον τρόπο κρούσης του λαούτου- διαφοροποιημένη ως προς την τοπική νησιωτική παράδοση.

Οι ηχογραφήσεις που πραγματοποιήθηκαν στο πεδίο (in situ) συνιστούν αναπόσπαστο κομμάτι της εθνογραφικής έρευνας και μεθοδολογικό εργαλείο της Οπτικοακουστικής Εθνομουσικολογίας (D' Amico, 2020). Το περιεχόμενο της κάθε ηχογράφησης συνιστά τεκμήριο του ηχοτοπίου του νησιού, προσφέροντας πληρέστερη κατανόηση του κάθε τοπόσημου ξεχωριστά, και αποτυπώνει τις χωροχρονικές συνθήκες του ηχοτοπίου (de Landa et al., 2016). Οι ερμηνείες των μουσικών επηρεάστηκαν από το ηχοτοπίο το οποίο επικρατούσε στο τοπόσημο που καταγράφηκαν. Χαρακτηριστικό παράδειγμα αποτελεί η καταγραφή στην Πηγή Βενιαμίν του Γιάννη Σέρβου⁴⁷ τον Ιούνιο του 2023, σε αντίθεση με τη καταγραφή του κ. Λευτέρη Ξέστερνου⁴⁸ τον Ιούλιο του 2023, εν μέσω δηλαδή καλοκαιριού, όπου ο ήχος των τζιτζικιών ήταν το αναπόφευκτο συνοδευτικό υπόβαθρο των συνεντεύξεων, ενώ ανάγκασε τους μουσικούς να παίξουν δυνατώτερα, επηρεάζοντας έτσι και την ερμηνευτική συμπεριφορά τους.

Συνολικά, σε όλες τις καταγραφές οι μουσικοί εμπνεύστηκαν και ενθαρρύνθηκαν στην ερμηνεία τους από το τοπόσημο της καταγραφής. Ταυτόχρονα, κατά τις καλοκαιρινές καταγραφές, παρατηρήθηκαν πολλοί ανθρωπογενείς προέλευσης ήχοι, εξαιτίας κυρίως του τουρισμού, οι οποίοι επενέβαιναν στο φυσικό ηχοτοπίο και στο ηχητικό υπόβαθρο της καταγραφής.

6. Διάχυση του έργου

Η διάχυση του έργου, η οποία ξεκίνησε με τη σταδιακή δημοσίευση των δέκα ολιγόλεπτων ντοκιμαντέρ στο ευρύ κοινό μέσα από την ιστοσελίδα του Δήμου Κέας, αποδεικνύεται μεγάλη. Σε λιγότερο από ένα χρόνο τα

⁴³ Βλ. Σίμος Κοζαδίνος διαθέσιμο στο: <https://cutt.ly/qeF6KlJo>

⁴⁴ Βλ. υποσημείωση 5

⁴⁵ Νίκος Κορασίδης διαθέσιμο στο: <https://cutt.ly/xeF6ZYHo>

⁴⁶ Νίκος Βουτυράς διαθέσιμο στο: <https://cutt.ly/yeF6XnMG>

⁴⁷ Γιάννης Σέρβος διαθέσιμο στο: <https://cutt.ly/teF6XO6H>

⁴⁸ Βλ. υποσημείωση 6

ντοκιμαντέρ έχουν συνολικά πάνω από 9000 προβολές. Κάθε ντοκιμαντέρ έχει ήδη ξεπεράσει το μέσο όρο προβολών που συνήθως έχουν τα βίντεο που προβάλλονται από την ιστοσελίδα του Δήμου Κέας. Αξιοσημείωτο είναι ότι οι περισσότερες προβολές, σύμφωνα με τα στατιστικά του youtube, προκύπτουν για τους ηλικιωμένους δεξιότεχνες, οι οποίοι έχουν μεγαλύτερη απήχηση σε σχέση με τους νεότερους που επιλέχθηκαν, παρότι οι νεότεροι μουσικοί είναι ενεργοί χρήστες του διαδικτύου και των κοινωνικών μέσων δικτύωσης, με αποτέλεσμα η διάχυση του ντοκιμαντέρ που τους παρουσιάζει να είναι σχετικά πιο εύκολη.

Επίσης, το έργο έχει λάβει δημοσιότητα μέσα από αναφορές του ηλεκτρονικού και έντυπο τύπου όπως: η εφημερίδα Καθημερινή⁴⁹ στις 31.03.2024 και 27.06.2024, η Lifo.gr⁵⁰ στις 19.04.2024 και η EPT 3 στην Εκπομπή Περίμετρος⁵¹ στις 09.11.2024. Επιπλέον, τα χαρακτηριστικότερα σημεία από τα ολιγόλεπτα ντοκιμαντέρ ενώθηκαν και δημιουργήθηκε ένα ενιαίο μεγάλης χρονικής διάρκειας αρθρωτό ντοκιμαντέρ με χαρακτηριστικό τίτλο: «Φυσάει τα βάσανά του και βγάνει μουσική...» που παρουσιάστηκε στις 14.04.2024 στην Κέα⁵².

Η λίστα με τα δέκα ντοκιμαντέρ στο youtube: <https://cutt.ly/DeF6VjHk>

7. Ευχαριστίες

Στο πλαίσιο της δράσης πολύτιμη ήταν η συνεισφορά των παραδοσιακών μουσικών που συμμετείχαν. Συγκεκριμένα οι συγγράφεις ευχαριστούν τους: Παπα-Λευτέρη Δεμένεγα, Νίκο Βουτουρά, Μηνά Πατηνιώτη, Λευτέρη Ξέστερνο, Σίμο Κοζαδινό, Αιμίλιο Λαγκώνη, Λευτέρη Ποδόγυρο και Γιάννης Σέρβο. Επίσης, τον Λευτέρη Τζουβάρα τέως Πρόεδρο της Κοινωφελούς Επιχείρησης Δήμου Κέας και τη Δήμαρχο Κέας Ρένα Βελισσαροπούλου. Τέλος, από το Μουσείο Κυκλαδικής Τέχνης τις υπεύθυνες του έργου Cycladic Identity, Γιούκη Κροντηρά και Θεανώ Αγαλόγλου.

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⁴⁹ Βλ. *Ο τσαμπουνιέρης φυσάει τα βάσανά του*, Ολοκληρώθηκαν τρία προγράμματα του Cycladic Identity σε Κέα και Πάρο

⁵⁰ Βλ. Αναζητώντας την προφορική και μουσική παράδοση της Κέας

⁵¹ Βλ. EPT 3 Εκπομπή Περίμετρος, Συνέντευξη στον Νίκο Πιτσιακίδη

⁵² Βλ. Διήμερο αφιερωμένο στη μουσική και την προφορική παράδοση της Κέας

The soundscapes of Kea as an auditory background for recording traditional instrumentalists

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Abstract

This research project, funded by the Cycladic Identity program of the Museum of Cycladic Art, documents the traditional music of Kea through ten independent documentaries featuring the island's last surviving old musicians. The study employs an innovative methodology that combines musical performances with in-situ recordings of local soundscapes, aiming to capture both the cultural heritage and the environmental context of Kea's music tradition. Recordings took place at various locations across the island, including historical sites and natural settings, during two sessions in June and July 2023. The project's uniqueness lies in its approach to simultaneously record traditional musicians' performances and the surrounding soundscape, providing a multifaceted portrayal of Kea's natural and cultural heritage.

The research applies acoustic ecology principles to produce high-quality audio and video recordings, integrating soundscapes and ambient sounds into the documentaries' narrative. It also includes ethnomusicological documentation of the performed songs, exploring interpretation differences based on musicians' origins and the impact of spatial-temporal conditions on their creative expression. This pioneering methodology in the Cycladic Islands offers a comprehensive framework for documenting, preserving, and promoting Kea's musical tradition while highlighting the intricate relationships between living beings and their auditory surroundings.

Keywords

Soundscape, field recording, traditional instrumentalists, documentaries, Kea



Keynote II

Phonographies and Soundscapes ⁵³

François-Bernard Mâche
<https://fbmache.fr/en/>

To deal seriously with a subject like the one I have adopted as my title would require much more than half an hour. You will therefore forgive me for having chosen instead to tell you about a long personal journey, the stages of which I am going to summarise for you today, choosing to speak more as a composer than as a musicologist. To do this, I will re-read and summarise the remarks in which I tried to justify my choices and in which I often came across our subject.

In 1958 I followed a curious path which led me to enrol in Pierre Schaeffer's GRM in February, in August before a jury as Agrégé des lettres classiques, and in October at the Conservatoire as a pupil of Messiaen. Choosing Schaeffer rather than Boulez was, despite a foreseeable career handicap at the time, the mark of a curiosity more oriented towards sounds than towards musical 'language'. *Musique concrète* seemed to me much more promising than the rediscovery of Schönberg and his school. As early as 1959, in one of my first articles, I proclaimed that all these new dimensions of sound, of which experimental music has brutally forced us to become aware, can no longer be said to be merely rich in the future: present in our music since yesterday, they are already its principal values.

If Boulez was starting out from Schönberg, I was planning to start out from Debussy and the Futurists. I wrote in the *Mercure de France* in November 1963:

'Music exists in nature, and we musicians are little more than intermediaries: sometimes we consciously gather it from its source and transcribe it; sometimes, by dint of culture, we forget the real meaning of our techniques, and we maintain the illusion of creating a pure and factitious art, a set of human conventions. But this music, too, lives only in the world of sound familiar to its creator, even if he or she no longer consciously listens to it, and all music, whether near or far from its sources, exists first in the world. Our gift is to make it heard'.

In looking for a sponsor, I couldn't fail to go back much further than the 1900s. Musicians' contact with the sound environment goes back to antiquity. As a teacher of ancient Greek, I had noticed that Plato, probably fighting Timotheus of Miletus and his school, had unwittingly preserved at least the memory of one realistic musician. It was undoubtedly him he was aiming at, when he wrote in *The Republic*:

'The blacksmith or any other workman doing his trade, the oarsmen giving the trier its momentum and the man whose voice stimulates them, or the horse neighing, the bull roaring, the lapping of the river, the sound of the wave breaking or the thunder, nothing must be imitated by the guardians of the republic.

Those who seriously undertake to imitate anything and in front of a large audience - thunder, wind, hail, axles and winches, the sounds of instruments, the cries of dogs, cattle and birds - lose sight of the only useful imitation, that of the good man'. For his part, the modernist attacked: 'I don't sing of old things, my new things are better. Zeus who reigns is young, and old Cronos no longer rules. Out with the old Muse!'

This aesthetic quarrel over sound realism, in opposition to music that was primarily concerned with symbols, has been perpetuated from century to century. A very special case is the imaginary invention of recording, the possibility of which Rabelais imagined in 1552 in the *Quart livre*, with a soundscape avant la lettre, where the sounds of a great battle between the Arimaspes and the Nephelibates (the cloud walkers), once frozen by the cold, are melting in the ears of Pantagruel and his companions.

⁵³ Editors' note: This text is a rendition of the slideshow presented at the Conference.

Windows open. In the morning, while sleeping.

*I hear voices. Gleams through my eyelid.
A bell is ringing in St Peter's church.
Shouts of bathers. Closer! Further! No, this way!
No, that way! The birds are chirping. Jeanne too.
Georges calls her. Roosters crow. A trowel
Scrapes a roof. Horses pass in the alley.
Squeaking of a scythe cutting the lawn.
Shocks. Rumours. Roofers walking on the house.
Sounds from the port. Whistling of heated machinery.
Military music coming in bursts.
Hubbub on the quay. French voices: Merci.
Bonjour. Adieu. No doubt it is late, for here
That my robin comes near me to sing.
Distant hammering in a forge.
The water laps. A steamer gasps.
A fly enters. The immense breath of the sea*

Victor Hugo : *L'art d'être grand-père* , book I poem XI. Written on 18 July 1870, near the port of Guernsey.⁵⁴

Like Hugo, I was aware, on an old sheet of paper that I have just found, of a vast space of which I noted the same boundaries between the sound of a very close fly and the more distant sounds of the port, mixing human voices and the sounds of life. And yet I didn't even know this poem existed when, in November 1961, sitting on a terrace in the old citadel of Oran in Algeria, I wrote down what I heard around me as a possible phonographie or soundscape (without rhyming, of course):

Oran, citadel, 1961 November, 1.20pm to 1.30pm:

Press office terrace, 1.20 p.m.

Background: distant rumour of traffic with slight movements (accelerations). Rare isolated distant horns.

Distant reverberated whistles.

3-4 regular knocks of metal against stone.

1 bird call fairly close by, isolated.

Rumour of flies very close by.

A soldier whistles occasionally.

A door slams, followed by acceleration, in the distance.

Whistles with echoes, high-pitched, on 3-4 semitones.

Nearby motorbike passes.

(the vast majority of sounds are the engine noises of cars, motorbikes, etc.)

Very slight rustling of nearby foliage

⁵⁴ *J'entends des voix. Lueurs à travers ma paupière.
Une cloche est en branle à l'église Saint-Pierre.
Cris des baigneurs. Plus près ! plus loin ! Non, par ici !
Non, par là ! Les oiseaux gazouillent. Jeanne aussi.
Georges l'appelle. Chant des coqs. Une truelle
Râcle un toit. Des chevaux passent dans la ruelle.
Grincement d'une faux qui coupe le gazon.
Chocs. Rumeurs. Des couvreurs marchent sur la maison.
Bruits du port. Sifflement des machines chauffées.
Musique militaire arrivant par bouffées.
Brouhaha sur le quai. Voix françaises : Merci.
Bonjour. Adieu. Sans doute il est tard, car voici
Que vient tout près de moi chanter mon rouge-gorge.
Vacarme de marteaux lointains dans une forge.
L'eau clapote. On entend haleter un steamer.
Une mouche entre. Souffle immense de la mer.*

2 close shocks (wood)
13.26 Car starting close by
13.27 Telephone ringing fairly close 1 time.
Woman's voice lecturing a child (?) close fast speech
13.30 Female laughter (same). Immediately harbour siren very loud asc.-desc. Rapid ascent (10'), stable (10'), very slow descent to low register.
Listening to these noises and listening to them as if chance were a musician, I'm not working on them, but on myself.

That same year, 1961, I used a long recording as a model for an orchestral work, *La peau du silence* (the skin of silence). It was a demonstration from California of the very recent invention of stereo. I was interested in the technique, but even more so in the beauty and diversity of the sounds recorded near the Pacific Ocean, and my orchestral writing is derived very closely from them:

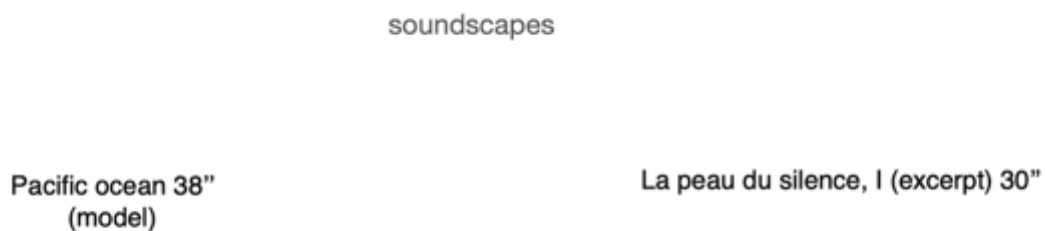


Figure 1

After my reference to Victor Hugo and the year 1870, I'll resume my historical overviews to recognise the importance of Ravel and Debussy, who, after Liszt, and above all after Monnet and the Impressionist painters, discovered and recomposed sonic landscapes, both competing to reproduce bells, water noises, animal voices and a few mysterious exotic sounds.

1897.	RAVEL.	Sites auriculaires pour 2 pianos.	Entre cloches
1901.	RAVEL.	Jeux d'eau	
1903		DEBUSSY.	Estampes (1.Pagodes, 2.soirée dans Grenade, 3.Jardins sous la pluie)
1904	RAVEL.	Miroirs (2.Oiseaux tristes, 3.Une barque sur l'océan, 5.La vallée des cloches)	
		DEBUSSY	L'isle joyeuse
1905		DEBUSSY.	Reflets dans l'eau
1906.	RAVEL.	Histoires naturelles (le paon, le grillon, le cygne, le martin-pêcheur, la pintade)	
1907.		DEBUSSY	Images,II, 1.Cloches à travers les feuilles, 2.Et la lune descend sur le temple qui fut, 3.Poissons d'or)
1908.	RAVEL.	Ma mère l'oye (5.Le jardin féérique)	
1909		DEBUSSY	Préludes I,5 Le collines d'Anacapri, I,6 Des pas sur la neige
1910		DEBUSSY	Préludes I,7 Ce qu'a vu le vent d'ouest
1912		DEBUSSY.	Préludes II,1 Brouillards

Figure 2

The GRM's documentation has enabled me to better recognise the historical importance of the Italian Futurists, in particular Pratella's first manifesto in 1911, and Russolo's two years later.

Francesco Balilla Pratella: **Manifesto of the Futurist Musicians**

...Everything will become possible when the conservatories, grammar schools and music academies are finally deserted and closed...

...The changing sky, the moving waters, the forests, the mountains, the sea, the smoky tangle of merchant ports, the great stormy capitals and their innumerable factory chimneys, will be transformed into powerful and prodigious voices through the musician's soul...

...The musician must listen only to his singing soul in the synthetic explanation of his musical ideas. The contrast of several musical states of mind, the relationships between their different expressions, their power to blossom, constitute the symphony...

1914 April 21: Futurist concert at the Dal Verme theatre in Milan.

The programme included 'Spirale de bruits' by Luigi Russolo's *Intonarumori* :

*Awakening of a capital city,
Dinner on the casino terrace,
meeting between cars and airplanes.
(The concert resulted in 11 minor injuries...)*

Sixteen years later, long before field recorders existed, attempts to recreate sound worlds as close to nature as realistically possible were frequent, and more or less successful, but everything changed with the advent of sound film. The first realistic soundscape was produced in 1930 by Walter Ruttmann, who had the idea of using the sound track alone from a film without images, *Wochenende*, to evoke the characteristic sounds of a weekend in Berlin.



Figure 3

The success of this precursor of *musique concrète* was not followed up immediately. A long time later, in an article published in *Le Mercure de France* in November 1963, I proposed to take up Ruttmann's approach with new means, and I tried to define what I had begun to illustrate with a few compositions such as *La peau du silence*:

Sound and music

...Music exists in nature, and we musicians are little more than intermediaries: sometimes we consciously gather it from its source and transcribe it; sometimes, by dint of culture, we forget the real meaning of our techniques, and we maintain the illusion of creating a pure, artificial art, a set of human conventions. But this music, too, lives only from the whole universe of sounds familiar to its creator, even if he no longer consciously listens to it, and all music, whether near or far from its sources, first exists in the world. Our gift is to give it a hearing...

...If music can proceed from an imitation of nature (sound), it is necessary to determine the limits and procedures of the necessary abstractions that the composer will have to make from the sound data he chooses.

The limits are relatively easy to set: minimum abstraction will be represented by an art, yet to be created, of 'phonographies', in which any sound elements, recorded with the greatest fidelity, would be assembled, with the least possible cutting, according to musical criteria and excluding any evocative, picturesque or dramatic intention. Maximum abstraction, on the other hand, occurs at the point where the structural laws derived from the sound model are indistinguishable from laws derived from any extra-sound reality. In other words, music that proceeds by conscious imitation of natural sounds (i.e., any unorganised sounds) will lie somewhere between the raw recording of such sounds and a work that could just as easily proceed from anything other than a sound reality...

I have remained fairly faithful to this twofold possible orientation, which proposes, in the case of the same interest in natural sounds, to choose between two orientations: phonographie as a 'ready made', or the soundscape as a more or less distant modelling of all or part of a sound episode. There are a number of differences here: a phonographie isolates an episode for a short period of time, even if that instant is prolonged or repeated, and focuses the listener's attention more on a nearby space. The soundscape embraces a time that can be much wider. But from a musical point of view, the limits of listening are not arbitrary, and the subjectivity of the author of a phonographie, like that of the listener, are determining factors that it would be imprudent to ignore.

A phonographie is generally nearby and the soundscape relatively far away. Space is an essential value in any sound recording. The choice of microphones, their directionality, their sensitivity and their location can strongly determine the result, and immediately disqualify any hope, any illusion, of total realism. Without recording, a soundscape remains a subjective, incommunicable and ephemeral impression, but on the other hand, any recording of sounds, as with images, is inevitably a manipulation of reality, and moreover it's never as permanent a reality as an image.

The most decisive step I took was in 1968, the year of a world crisis that encouraged all kinds of daring. I decided not to respect the opinion of Schaeffer, who postulated that an essential condition for composing with recorded 'noises' was to conceal their origin, in order to transform vulgar sound signals into musical symbols. Influenced by the lessons of structural linguistics, I thought that it was the context, and not the physical nature of the sound, that decided what meaning could be given to it. *Rituel d'oubli* opens with a phonographie of the close-up vociferations of a hornbill, followed by the rhythmic whirling of the Neolithic magician's instrument, the bullroarer. Two sounds that are alien to each other as signals, but that can create an imaginary, (i.e., musical), space.



Figure 4

In a composition like *Naluan*, two years later, I tried a type of inclusion of natural sounds, birdsong, which had always been recognised as the most musical. I had avoided this until then, so as not to appear to be merely a follower of Messiaen's brilliant creations. At the time, no software application was yet available to facilitate

transcription, an essential step for coordinating these recordings with an instrumental score. So, for months I had to do a huge amount of musical dictation for a wealth of birdsong. When *Naluan* was premiered, after Baden Baden, in Paris on November 28 1974, Messiaen was there. He, who until then had showered me with great compliments, appeared particularly embarrassed, speaking of the 'excessive realism' of my recorded birds. I was both disturbed by his disagreement, and yet relieved to have opened up a path away from this great model.

1974

Naluan,
excerpt 1'14

ensemble Fa, dir. Dominique My

Figure 5

Two years later, in 1976, Murray Schaffer, whom I had once met briefly in Paris, published his resounding *Tuning of the World*, a book full of ideas, references and suggestions. It was essentially the vast study of a perceptive sociologist, while his approach as a composer seemed to take a back seat.

Murray Schaffer: Our sonic environment and The Soundscape, the tuning of the world (excerpts)

"...Music is of two kinds: absolute and programmatic. In absolute music, composers fashion ideal soundscapes of the mind. Programmatic music is imitative of the environment

...As the transistor radio revives interest in the outdoor concert and the guitar returns to orchestrate the baraque de foire of the rock concert, we may accordingly expect to witness a deterioration of manners at concert halls, as concentrated listening gives way to impressionism.

...the exaggerated echo and feedback effects of modern electronic and popular music re-create for us the echoing vaults, the dark depths of ocean.

...The sounds of the environment have referential meanings. For the soundscape researcher they are not merely abstract acoustical events, but must be investigated as acoustic signs, signals and symbols.

...The sea has always been one of man's primary symbols in literature, myth and art. It is symbolic of eternity: its ceaseless presence. It is symbolic of change: the tides; the ebb and flow of the waves".

2010

Le promeneur solitaire
(The solitary walker)
soundscape (wolves) 1'11"

Figure 6



2016

Alcyone
(phonography, excerpt)

Maki Belkin
0'28"

Figure 7

Conclusion

From a composer's point of view, soundscapes are a special case of his widespread reference to models, not an autonomous and marginal practice in his relationship with sound. The fact that spoken recordings, animals, elements, urban noise, etc. could be defined under a common category of models implied that man accepted that he is one of nature's voices, outside any history, and feels some relief at that.

It was then that my thinking led me to question the very origin of my 'naturalist' practice. At first, I thought I'd found a way to avoid the intellectualism, nihilism and backwardness of many other aesthetic orientations. Then it occurred to me that this very practice had natural foundations and models, and was therefore partly immune to arbitrariness. I realised that it was not just a heuristic method, a production technique, a musical poetics, but also obedience to patterns whose existence goes far beyond humanity alone. The use of natural models in music raised questions of an anthropological, not just an aesthetic, nature. For me, talking about phonographies and soundscapes meant above all a search for harmony with a world acceptable to man, not a painful limitation brought to his freedom.

Today, this research takes on a resonance of intense nostalgia that is somewhat derisory, because it is nature itself which is threatened. Tragically, the animal voices whose musical potential I have tried to express on several occasions are giving way to a growing silence. Sometimes I hope that my music may have a tiny place among the archives of a vanished world, if there is still any humanity left to consult any archives. Will there be listeners tomorrow among the people trying first to survive?

Please excuse me if I end this overview of a rather gourmet exploration with the spectre of a terrible threat of famine. Musicians sometimes let out the wrong notes...

Με συγχωρείτε αν τελειώσω αυτή την επισκόπηση μιας μάλλον γκουρμέ εξερεύνησης με το φάσμα μιας τρομερής απειλής λιμού. Οι μουσικοί μερικές φορές βγάζουν λάθος νότες...

A watercolor illustration of a dark bird perched on a branch, with the text "Bioacoustics, biodiversity, and climate crisis" overlaid. The bird is dark with a white eye and is perched on a light-colored branch. The background is a soft, light-colored wash with some darker, textured areas. The text is in a bold, black, sans-serif font.

Bioacoustics, biodiversity, and climate crisis

Bioacoustics and videogames as transformative media to engage the public in sustainability. Restoring blue carbon habitats in the Philippines

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Abstract

This paper explores how bioacoustics data, video gaming and environmental recordings can merge to become a transformative pathway for engaging people in sustainability research. Focusing on 'Mangrove World', a climate-action video game developed by KeepItHuman—a studio and spin-out company at the University of Manchester—the study builds on the foundation of existing environment-themed games. 'Mangrove World' is a collaborative project involving KeepItHuman, Oceanus Conservation - a blue carbon conservation and restoration NGO in the Philippines and Imago Software, the University of Manchester's student software company.

Environmental audio-loggers and sound recordings were used to capture three contrasting aural fingerprints of mangrove habitats in the Philippines such as La Union, Manila Bay (Makati) and Bais in Negros Oriental. These recordings, alongside additional acoustic data analysis, aimed to build a pilot study with two key objectives: First, to be combined with other monitoring systems used by Oceanus Conservation such as remote sensors, orthomosaic mapping through satellite and drone observations and citizen science data. Second, it aimed to play a central role in co-designing the video game Mangrove World, incorporating original music themes and interviews with local communities. The project's goal was to raise awareness among young people about the urgent need for mangrove reforestation and conservation. In the game, players must plant mangrove trees in a race against time to save island 'Kapakanan' before a deadly typhoon strikes.

Keywords

Bioacoustics, Mangrove reforestation, video games, Philippines, AudioMoth, Education for sustainable development, citizen science, rainforest, climate change

1. Introduction

Mangroves ecosystems provide five times higher carbon sequestration than terrestrial forest, as they are considered the most productive coastal wetlands that sustain and store blue carbon (Choudhary. et al., 2024). Mangroves strongly contribute to mitigating the impacts on local communities of coastal disturbances such as tsunamis, typhoons and extreme storms while supporting the implementation of the United Nations Sustainable Development Goals 2016–2030, (Koh et al., 2018, pp. 446-460.). Alongside climate mitigation, a Mangrove ecosystem provides a wealth of economic resources, leading to local livelihood.

This paper explores how co-designing a climate-action video game entitled *Mangrove World* based on a field recording project in the Philippines, can serve as a transformative tool to promote sustainability research and inspire positive climate action. Led by KeepItHuman Studios, a spin-out enterprise within the University of Manchester's Music Department, the project was developed in collaboration with Oceanus Conservation, a Philippine NGO dedicated to blue carbon conservation and restoration and Imago software at the University. The co-creation process involved various methodologies, including the collection of environmental recordings across three distinct mangrove reserves in the Philippines. The team deployed acoustic loggers, conducted bioacoustics data analysis, and engaged with local communities through activities such as planting mangrove seedlings and interviewing local community leaders.

2. Environment-themed games

Educational games are potential tools for communicating climate science to the public and thus improving public understanding of climate change (Foltz, et al., 2019). Research questions such as ‘can environment-themed games, however well-intentioned, actually help people learn about climate change?’ or ‘could they change the public’s attitude toward the science and help illuminate the impact on people and ecosystems?’ have already been examined by multidisciplinary collectives such as EarthGames, a group of scientists, educators and game designers who are developing climate change focused games (Kwok, 2019). EarthGames methodology spins around the organisation of climate change video game jams for participants to prototype games in a relatively short period of time, along other activities such as game reviews. Early studies suggest that after playing, people reported increased feelings of urgency and hope (Rooney-Varga, 2018). Additional findings confirm that gaming increases the sense of personal responsibility, the confidence in politics for climate change mitigation and makes more optimistic about international cooperation in climate politics (Meya & Eisenack, 2018). A key objective of the field trip was to further investigate the role of sound recordings, themed music and acoustic analysis as integral elements of the game, to build upon these additional findings. In *Mangrove World*, sonic materials and the interactive media experience were designed not only to shape the game’s narrative and provide players with a firsthand understanding of the challenges surrounding mangrove restoration but also to create added value for our nonprofit partners and the local communities. Another important aim was to build a sense of trust in the video game, fostering stronger connections between players and the world of mangroves and to highlight the need for reforestation, coastal protection and broader restoration efforts.

3. Recordings Mangrove habitats in the Philippines

The project’s research methods included bioacoustics and sound recording devices deployed across three distinct mangrove ecosystems in the Philippines, each with varying levels of climate risk and management practices.

3.1. Field work:

Location 1: In La Union, located in northern Philippines, mangrove habitats are primarily managed by local communities with support from local government. Along with capturing audio logs and sound recordings, the field trip included an interview with community leader Delilah Yaranon, (Figure 1) and KeepItHuman’s participation in planting 400 mangrove seedlings in Barangay Aringay, La Union. To date, Oceanus Conservation, in collaboration with local communities and student volunteers, has planted a total of 4,289 seedlings across Salay and La Union. (April 2022 data).



Figure 1. Camille Rivera (left), Oceanus Conservation co-founder, mediating KeepItHuman interview to community leader Delilah Yaranon (right)

Location 2: Makati - The *Las Piñas-Parañaque* Wetland Park, a small reserve near Makati, houses mangrove ecosystems that are severely threatened by their proximity to Manila's Ninoy Aquino International Airport. Figure

2 below depicts plastics that have drifted from Manila Bay, accumulating along the park's mangrove-lined coast. Heavier items, like bottle caps, are often collected in bulk for paid recycling schemes, while lighter plastic bottles are frequently left behind as they take up more space.



Figure 2. Plastic rubbish found by the mangrove coastal line at *Las Piñas* Wetland Park, Makati

Location 3: Bais, Negros Oriental, is home to the Talabong Reserve (figure 3-4), a government-protected mangrove area with restricted public access. Research fieldwork was facilitated by Sir Lito, the head sea warden at Bantay Dagat, with support from Vic Ross, Angela Mariz Obsina and Emmanuel Cababarro from Oceanus Conservation.



Figure 3. From left to right, government official Sir Lito, KeepItHuman founder Ricardo Climent (holding an acoustic logger) and Oceanus supporting staff Emmanuel Cababarro and Mariz Obsina



Figure 4. A map of the three recording sites and MicroMoth deployment locations

3.2. Returning value to the NGO

Oceanus Conservation currently manages three mangrove nurseries and has planted 14,415 mangrove saplings, successfully saving 71 hectares of mangroves from degradation. The organization has distributed 117 bilingual ocean storybooks, trained 240 community members and engaged 739 young people in its Ocean campaign. Their goals for 2023 included restoring an additional 10 hectares of degraded mangrove areas by year's end, (Oceanus Conservation. (n.d.)).

Project targets and data sources: The aim of KeepItHuman's acoustic data analysis was to develop a case study using wildlife recordings from mangrove habitats to assess and compare the health of three distinct mangrove ecosystems. This acoustic analysis was not intended to replace the existing monitoring systems utilised by Oceanus Conservation; rather, it aimed to complement their current datasets and practices. Oceanus employs remote sensors, orthomosaic mapping via satellite and drones, as well as costly citizen science contributions, including photographs and other forms of hand-tracked observations to gather data from the coastal areas they protect and manage.

Data collection on mangrove zones has involved collaborations between Oceanus Conservation and several organisations, including the Massachusetts Institute of Technology (MIT), Thinking Machines Data Science, GainForest, and the National Geographic Society. Since 2022, the team has collected a total of 3,267 mangrove data points and 199 seagrass data points from various locations in the Philippines (as of 2023).

In addition to mangrove data, Oceanus utilises Smart Buoys as part of Project SCORE to monitor coral reef health, gathering real-time information on bleaching events that threaten over 500 species of stony corals in the Philippines and advocating for local protections. Project SCORE is a partnership between Oceanus, De La Salle University SHORE, LGU Lian and the Lian Fisherfolk Association. The data from Project SCORE aids in understanding sea temperature trends and their correlation with coral reef health. The first buoy was deployed in Lian, Batangas, in January 2021, followed by a second buoy in Coron, Palawan, in February 2022.

3.3. Recording strategy

Equipment: Fieldwork recording devices ranged from 6x battery-powered full-spectrum acoustic loggers, capable of recording uncompressed audio to a microSD card at rates up to 384,000 Hz – the MicroMoth –, a smaller-size version of the AudioMoth with waterproof and underwater proof cases; an Aquarian H2D hydrophone; a DPA 4060 miniature omnidirectional stereo microphone Kit; a Rode NTG5 shotgun microphone kit; an ETHER by SOMA a wide-band electromagnetic receiver (which also captures signals from trees); a Sound Devices MixPre-10 recorder and other supporting recording equipment.

We experimented with the deployment of acoustic loggers, collecting them overnight in La Union, deploying them during low tide at Bais, in Negros Oriental and collecting them during high tide. In terms of geolocate tracking, we used GPS markers on a mobile phone to determine each approximate point of deployment of the MicroMoths (Figure 5). We also tied coloured cloth strips to the higher branches of each mangrove holding an acoustic logger, or to those nearby and closer to the walking paths. Forest paths and coastal environments look very different on high tide, as the water partially covers mangroves and footsteps are no longer traceable.



Figure 5. Left: Fieldwork at Bais (Mariz, Ricardo and Emanuel) and right: the recording kit

3.4. Acoustic analysis and barriers in the recognition of clustered species: For the acoustic analysis tests, we used Kaleidoscope Pro (a yearly licensed product), Wildlife Acoustics. (n.d.). This software uses pattern recognition algorithms training a Hidden Markov Model to cluster audio recordings from local wildlife, including birds, mudskippers, frog calls, bat echolocations using its ultra range recording capabilities, or other sounds species. The process normally involves the following steps:

- To build a collection of recordings from the MicroMoth SD card: audiofiles were recorded at intervals of 55 seconds, with a 5 second rest before starting a new recording. This is a safer procedure than recording much larger files, which may be lost in case of draining the battery power.
- Basic cluster analysis of an initial batch of input audiofiles: this process analyses different types of vocalisations and other sounds using the statistical model. The sample needs to be large enough.
- Once vocalisations from these input files are sorted by the algorithm into clusters based on similarity, the audio cluster needs to be labelled with the name of the species behind each played cluster.
- The output files are saved as cluster.csv and cluster.kcs – the latter is used as a simple classifier to identify similar species in a different batch of audio files.

In Kaleidoscope Pro, advance classifiers can provide more discriminating features than the input classifiers and reduce false positive identifications, (figure 6). In its simpler version (LITE) Kaleidoscope can still open audio files and provide spectral analysis, filtering and playback (at different rates) of focused sections within the audio file.

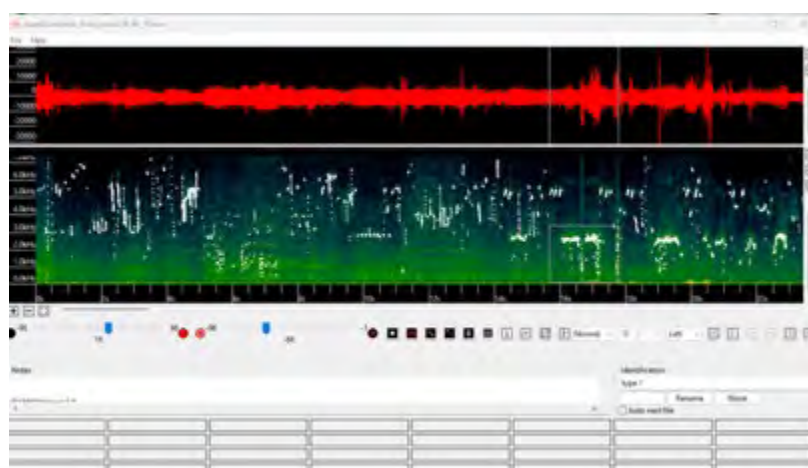


Figure 6. Spectral analysis of an audio recording in Kaleidoscope Pro

3.5. Further audio work needed. Identification and labelling of species: Identifying the vocalisations of birds and other species is essential for labeling the aural features captured in wildlife recordings. To accomplish this effectively, collaboration with an experienced wildlife scientist who specialises in both local and migratory

species is crucial, particularly for distinguishing between resident and migratory birds. Additionally, there is scientific literature detailing the local and migratory species found in mangrove and intertidal zones in our sampled area of Bais, Negros Oriental, Talabong Mangrove Forest, (Tables 1-2), (Oracion, 2022, pp. 561–573). We collected samples in the month of July (pre-migratory period).

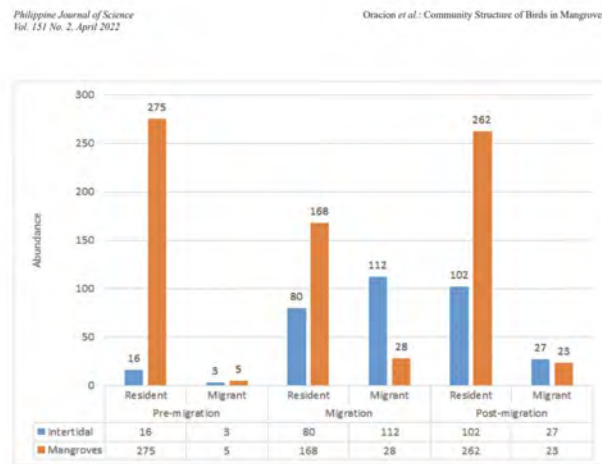


Table 1. Abundance of birds occupying the intertidal and mangrove areas

Table 3. Relative abundance for each bird species. The symbol (—) indicates no record of that particular bird.

	Status	Pre-migration		Migration		Post-migration	
		Intertidal	Mangrove	Intertidal	Mangrove	Intertidal	Mangrove
Barn swallows	Migrant; common	—	—	3.13	1.02	5.43	—
Barred rail	Resident; common	—	1.79	—	2.55	—	1.75
Blue-tailed bee-eater	Resident; common	—	—	—	0.51	—	0.35
Budmerry bit	Resident; common	—	—	—	—	—	0.35
Brown shrike	Migrant; common	—	—	—	1.02	—	1.40
Chestnut munia	Resident; common	—	6.07	—	—	—	10.18
Chestnut-crowned tailorbird	Endemic; common	—	1.07	—	1.02	—	4.21
Collared kingfisher	Resident; common	5.26	17.50	—	12.24	1.55	6.32
Common kingfisher	Migrant; common	—	—	0.52	7.14	1.55	2.46
Golden-bellied gerygone	Resident; common	—	20.36	—	23.47	—	24.56
Great egret	Migrant; common	—	—	1.04	—	—	—
Grey-tailed titlark	Migrant; common	—	—	0.52	—	3.88	0.35
Intermediate egret	Migrant; common	—	—	5.21	—	1.55	1.40
Little bronze-cuckoo	Migrant; uncommon	—	1.43	—	1.53	—	1.40
Little egret	Migrant; common	15.79	—	33.85	3.06	3.10	—
Olive-backed sunbird	Resident; common	—	5.36	—	13.78	—	17.84
Oriental reed-warbler	Migrant; uncommon	—	0.36	—	—	—	1.05
Oprey	Resident; common	—	0.36	—	—	—	—
Philippine duck	Endemic; common	52.63	15.00	38.02	19.71	71.32	0.35
Philippine glossy swiftlet	Resident; common	—	4.64	1.56	4.39	3.88	4.56
Philippine magpie-robin	Endemic; common	—	2.50	—	2.04	—	2.81
Philippine nightjar	Endemic; common	—	0.36	—	—	—	—
Philippine pied fantail	Endemic; common	—	6.07	—	6.12	—	9.12
Philippine yellow-vented bulbul	Endemic; common	—	—	—	0.51	—	1.75
Pied triller	Resident; common	—	2.14	—	1.02	—	0.70
Pink-necked green-pigeon	Resident; common	—	—	—	0.51	—	2.81
Plaintive cuckoo	Resident; common	—	2.50	—	—	—	0.70
Rufous-night heron	Resident; uncommon	—	—	1.56	—	0.78	0.35
Scaly-breasted munia	Resident; common	—	3.57	—	—	—	—
Strailed heron	Resident; common	26.32	4.29	0.52	3.57	1.55	0.70
Whistler	Migrant; common	—	—	—	0.51	0.78	1.40
Whiskered tern	Migrant; common	—	—	14.06	—	4.65	—
Zebra dove	Resident; common	—	4.64	—	3.06	—	1.05

Table 2. Relative abundance for each bird species

Additionally, on October 12, 2024, Oceanus Conservation celebrated the World Migratory Bird Day (n.d.), by conducting a bird census in Negros Oriental with the members of the United Fisherfolk Association of Capiñahan (UFAC), together with the Executive Director Pol Cariño (PENAGMANNAK, Inc. and member of the Wild Bird Club of the Philippines) and Jean Henri M. Oracion (Department of Biology, Negros Oriental State University). ‘The bird census was able to identify a total of 20 bird species this season (332 individuals), 8 of which were migratory bird species; 11 species were resident, while 1 was endemic to the Philippines and tagged in the IUCN Red List as vulnerable species, due to habitat loss and population decline. Philippines is one of the major migratory pathways of waterbirds like egrets, terns, sandpipers, and stilts that fly through the East Asian-Australasian Flyway (EAAF).’ (Oceanus Conservation, n.d.). Therefore, there is strong potential for further expansion and data crossing of the research.

4. Research imperatives, co-creation, dissemination and player tests

For KeepItHuman, one of the key research imperatives of this project was to understand the significance of the fieldwork conducted in the Philippines. We posed several questions, including: Can the collection and analysis of wildlife recordings in mangrove areas help construct a new narrative for the video game? Do scientific data and local community testimonies foster trustworthy connections between players and the cause? Has the game prototype raised awareness about the need for mangrove conservation and reforestation? How can KeepItHuman provide value back to Filipino partner, Oceanus Conservation? Lastly, can this video game facilitate a transition from a virtual experience to real-world actions?"

4.1. In-game KPIs: KeepItHuman and Oceanus Conservation agreed on the following key performance indicators (KPIs) to embed in the gameplay or explore during their partnership:

- Raising Awareness: Highlighting the environmental, social and economic value of reforestation.
- Data Collection: Utilising audio loggers for the co-evaluation of mangrove ecosystem health.
- Citizen Science Engagement: Promoting participation among young people outside the Philippines.

4.2. Funding and co-creation with University of Manchester students: *Mangrove World* project was funded by the Faculty of Humanities Recovery Fund at the University of Manchester, UK and by Innovation Factory, the University's commercialization branch. Innovation Factory enabled KeepItHuman to collaborate with Imago Software, led by Dr. Suzanne Embury, to recruit computer science students who assisted with coding the game, contributed ideas and conducted preliminary questionnaires on campus. The Recovery Fund facilitated travel to the Philippines for data collection, outsourcing the game art and aesthetics and supported playtests and additional questionnaires at the University campus by Dr Adriana Ruiz, KeepItHuman marketing director.

4.3. Composition materials: The upcoming recording catalogue by KeepItHuman was intended to be an integral part of the soundscape for the *Mangrove World* video game, significantly informing the musical themes and the layered audio stems created in Unreal Engine by composer Benoît André. These sound recordings also hold the potential to serve as the foundation for a new soundscape project or documentary film by the co-author of this paper. Future exploration avenues include utilising Oceanus Conservation's Smart Sensor buoys, which gather real-time sea current temperature data. This dataset could be integrated into the game in real time via an API for Unreal Engine 5, providing scientific data on in-game water currents and coral reefs within *Mangrove World*.

4.4. *Mangrove World* trials targeting young audiences:

We ran several trials across the University of Manchester campus collecting data from student players and staff. 94% of player respondents in the questionnaire, [Google Drive file] (n.d.), stated that playing and interacting in *Mangrove World* increased their awareness of the importance of mangrove forests for their local ecosystems. The collaboration also aimed to highlight broader social and economic issues observed from an environmental sustainability perspective, to communicate sustainable research and its SDGs.

4.5. Additional dissemination of project findings and impact includes:

- Conference paper and Video Game Demo: Presented to ca. 400 hundred conference attendees at MMM6 2023, Cartagena de Indias, Colombia, during the Sixth Mangrove Macrobenthos and Management conference, themed "Mangrove Ecosystems for Human Well-Being in a Changing Planet."
- Bluedot Festival 2023: Hosted a stand in Manchester, UK, with Dr. Adriana Ruiz, showcasing KeepItHuman games at the Creative Manchester stall.
- Game Trials at Café 18, Bogotá: Organised sessions with a group of parents and their children to play *Mangrove World* and gather impressions and suggestions.
- Presentation at SensorLab, Universidad Javeriana Pontificia, Bogotá: Invited by composer Ana María Romano, featuring talks by Ricardo Climent, Adriana Ruiz (KeepItHuman) and Diana Restrepo. The forum theme was 'Sound & the Environment: Curious Listening Against the Anthropocene.'
- *Mangrove World* served as case study for a successful funding application to Sustainable Futures in 2023 to build KeepItHuman's video game *Resourceful World* on sustainable energies.

- Exhibiting KeepItHuman video games at GAMESCOM 2023: Participated in Cologne as part of UKie – UK Interactive Entertainment. It is the largest video game conference in Europe with ca. 350.000 attendees.
- Manchester Science Festival 2024 (October): as part of EXTREME GAMING; target player age: 8–14.
- 7th Conference on Acoustic Ecology: Scheduled for Athens, Ancient Epidaurus (November 2024) with the theme "Soundscapes, Biophony, and Climate Crisis."
- Guerrilla Games Festival (November 2024), Matadero, Madrid.

4.6. Further development work: 'Virtual-to-Real' conversion: In previous KeepItHuman video games, such as *Timbi World*, *Keep It Human*. (n.d.), we explored the concept of 'virtual-to-real' conversion by aligning the multiplayer game with a *GoFundMe* campaign for NGO Maputo Skate in Mozambique. This crowdfunding initiative enabled the video game studio to send real skateboards to the African NGO as players successfully completed missions by playing music together within the game. We also developed a companion AR app to trace back donations, so that Maputo skate children could take a selfie for the donor with themselves, character *Timbilikio* and the given skateboard.

During the field trip to the Philippines, KeepItHuman participated in an Oceanus-organised event to plant 400 seedlings in La Union, (figure 7). This raised the question of whether *Mangrove World* could facilitate real donations of seedlings through in-game actions, thereby further supporting the expansion of mangrove reforestation activities. Additionally, we considered whether collecting authentic wildlife recordings of mangrove sites and species in the Philippines would enhance the likelihood of success for a potential crowdfunding campaign.



Figure 7. Left - Camille Rivera (Oceanus Conservation co-founder) giving instructions to a group of volunteers before planting 400 seedlings at La Union. Right: KeepItHuman founder R. Climent at the event

5. Conclusions

This project aimed to build upon existing research on environment-themed videogames as a potential tool for communicating climate change by developing a focused case study using wildlife recordings from mangrove habitats to assess and compare the health of three distinct mangrove ecosystems.

Field recordings and community work in the Philippines strongly informed and focused the development of video game *Mangrove World*, raising new questions about the role of sound recordings, themed music and scientific data as key material for game development while highlighting their environmental sustainability role.

Acoustic analysis of mangrove sites can help as a complementary monitoring method to measure the health of an ecosystem, but knowledge about local species and birds' migration will be necessary for success and progress.

Sound and visual media in video games can act as catalysts to build a sense of trust in the digital, fostering stronger connections between players and the world of mangroves, creating awareness about the need for mangrove reforestation and coastal protection beyond mangrove species.

Field work including acoustic analysis of mangrove sites and reserves can not only strongly shape the game's narrative but also create added value for NGO partners (i.e. Oceanus Conservation) and their local communities.

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"The Song of Blackbird": a bioacoustic and musicological approach

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Abstract

*The spring soundscape in the city is a rich mosaic of sounds in which blackbirds play a key role. The blackbird (*Turdus merula*) is known for its melodic song. Song learning is extremely similar in songbirds and humans and relies on a specialized set of brain regions. The song of adult blackbirds includes imitation of other bird species and even environmental sounds. The song of the blackbird is repetitive, with males developing a distinctive sequence of notes that occur frequently. The European blackbird in particular is known for its improvisational abilities, adding variations and new sequences to its songs. The degree of polysyllabicity in blackbird song is another characteristic of the species. According to the approach of French composer Olivier Messiaen, the integration of song of songbirds involves not only direct transcription but also adaptation and harmonization to fit its unique musical language. In pop music there are many references that highlight the symbolic importance of the blackbird. The aim of this study is to analyse and compare the songs of blackbirds coming from three different regions of the Mediterranean, in order to gain a comprehensive understanding of their songs that include both their biological functions and their artistic skills.*

Keywords

Blackbird song, Ornithomusicology, bioacoustics, Mediterranean regional differences, birdsong structure, improvisation, musical form, Olivier Messiaen, song variation, bird communication, song learning, subspecies comparison, artistic inspiration

1. Introduction

In this article we will present the song of the blackbird as a source of inspiration for the field of ornithomusicology through the models of Olivier Messiaen's predecessors, François-Bernard Mâche, in order to understand elements related to the structure of its musical form. Therefore, we will enter the fields of ornithological biologists to understand if the song of the blackbird differs in regions of Europe and more specifically in the Mediterranean. We also refer to the song cycle at different times of the year in the three different subspecies of *Turdus merula*, *Turdus merula mauritanicus*, *Turdus merula aterrimus*, *Turdus merula cabreræ* with emphasis on the fact of the completion of the song cycle as a characteristic of all three subspecies. In forests, the dense foliage and structures create unique acoustics, often leading blackbirds to sing with specific frequencies and rhythms that help their calls travel efficiently through the trees. Gilles Deleuze, together with Félix Guattari, explored birdsong and refrains in *A Thousand Plateaus*, where they used bird behaviours, such as singing, to illustrate how creatures create and mark territory in expressive ways. This act of territorial marking, or creating a "refrain," extends beyond functionality to art-like expression. Deleuze and Guattari argued that birds transform components of their surroundings—like specific songs—into these refrains to both establish and express their territories. Birds thus engage in forms of "artistic" or musical territorialization long before human beings did. (O'Sullivan)

2. State of the art

Male blackbirds are strikingly black with an orange-yellow beak and eye-ring, while females and juveniles are brown with lighter streaking. Adult males are often seen singing from exposed perches, particularly in spring. Blackbirds are omnivorous, eating a variety of insects, earthworms, and berries. Their diet can shift seasonally

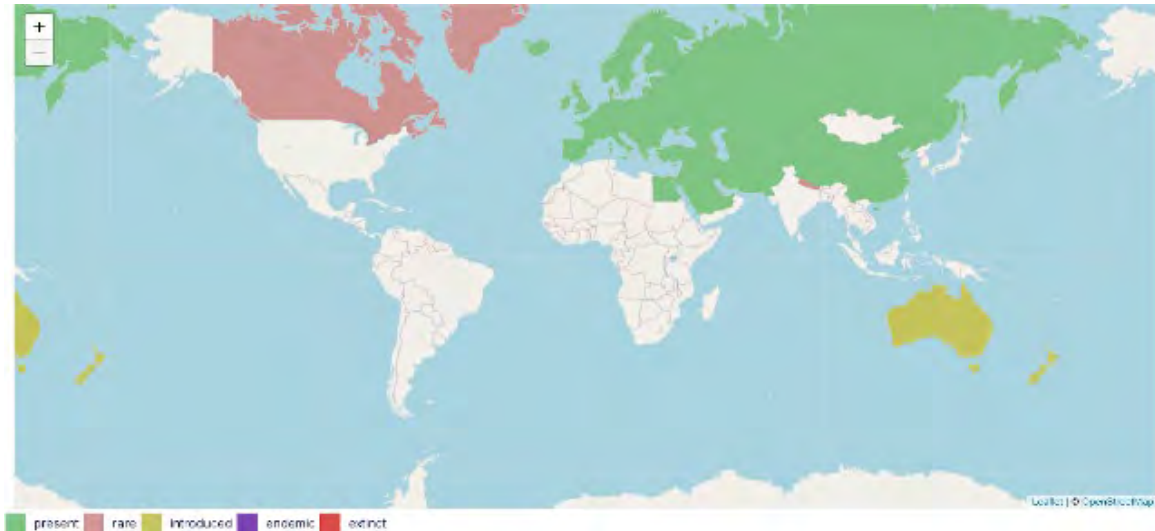
and with habitat, with forest blackbirds tending to rely more on invertebrates found within leaf litter and urban blackbirds on food scraps and garden insects. *Turdus merula* is commonly found across Europe, Asia, and North Africa, in diverse habitats ranging from forests to city parks. (Hassani) Blackbirds (*Turdus merula*) are one of the most widespread passerine species in the Western Palearctic zone. They are commonly found in farmlands, woodlands, and suburban environments, and are particularly adaptable to human-modified habitats. They are highly successful breeders, often nesting in trees and shrubs. Nest height is often influenced by the height of the supporting tree. They begin nesting in late April or early May, with laying and hatching occurring in May and June. Breeding success rates are generally high. Nests are usually cup-shaped, built from twigs, leaves, and mud. They are often placed in the centre of apple orchards, providing good protection from predators. The most common causes of nesting failure include predation by reptiles, nest desertion due to human disturbance, and mortality of chicks.

Distribution				
Display regions:				
North America [rare/accid.]	Luxembourg	Balkans	Cyprus	Kyrgyzstan
North America (US/Can) [rare/wood.]	France	Slovenia	Syria	Tajikistan
Amer. Ornithol. Union [rare/accid.]	Portugal	Croatia	Lebanon	Afghanistan
Amer. Birding Association [rare/accid.]	Spain	Bosnia-Herzegovina	Israel	China
Canada [rare/accid.]	Gibraltar	Yugoslavia	Israeli occupied territory	Nepal [rare/accid.]
Europe	Andorra	Serbia and Montenegro	Jordan	South Asia
Continental Europe	Monaco	Serbia	Arabian Peninsula	Pakistan/India/Bangladesh
Eastern Europe	Switzerland	Serbia	Saudi Arabia	Pakistan
Western Europe	Liechtenstein	Kosovo	United Arab Emirates	India [retracted]
Iceland	Germany	Montenegro	Qatar [rare/accid.]	Hong Kong
Scandinavia	Austria	Albania	Bahrain [rare/accid.]	Southeast Asia
Norway	Italy	Macedonia	Kuwait	Indonesia
Sweden	San Marino	Greece	Iraq	Oceania
Finland	Vatican State	Malta	Iran	Australasia
Denmark	Baltic	Bulgaria	Armenia	Australia [introd.]
Faroe Islands	Estonia	Romania	Azerbaijan	New Zealand [introd.]
Greenland [rare/accid.]	Latvia	Ukraine	Georgia	Malaysia [introd.]
Britain and Ireland	Lithuania	Moldova	Asia	Holarctic
British Isles	Belarus	Africa	Soviet Union	Palearctic
United Kingdom	Poland	Continental Africa	Russia	Western Palearctic
Ireland (Iland)	Czechoslovakia	Northern Africa	Turkmenistan	Nearctic [rare/accid.]
Ireland	Czech Republic	Egypt	Kazakhstan	
The Netherlands	Slovakia	Middle East	Uzbekistan	
Belgium	Hungary	Turkey		

Display Regions of the Eurasian Blackbird *Turdus merula* Linnaeus

Understanding their breeding biology and success rates is important for developing conservation management strategies and for making comparisons across different geographic areas. Blackbirds are territorial, particularly during the breeding season, and can aggressively defend their nests from intruders. Blackbirds are monogamous and highly territorial during the breeding season. Nests are typically low to the ground and built with grasses, mud, and leaves. A single pair can raise two to three broods per season, with young blackbirds becoming independent within a few weeks. This ability to modulate singing behaviour, diet, and nesting strategies highlights *Turdus merula* as a highly adaptable species, capable of thriving in both natural and modified landscapes.

Their adaptability to sound, in particular, underscores their resilience in adjusting to urbanization and environmental pressures. Blackbird songs are highly complex, with a wide repertoire of motifs, rhythms, and pitches. There's a great deal of individual variation between blackbirds. They can reach very high pitches, often exceeding 5,000 Hz, with some reaching even 8,000 Hz and can exhibit a wide range of emotional contrasts in their songs, with some passages being mocking, ironic, and joyful, while others are calm, peaceful, and solemn. They often exhibit a fragmented song structure, with frequent breaks and repeated motifs. They typically start at a relatively low frequency, jump upwards, and end on an extremely high pitch. The forest habitat can absorb and muffle sounds, so blackbirds may sing at frequencies that minimize sound loss and reverberation in dense vegetation. Blackbird song in forests changes seasonally, with males singing prominently in spring and summer to establish territories and attract mates. This song is usually quieter or more restrained in forests than in open areas, possibly due to the need for short-distance communication.



Eurasian Blackbird's *Turdus merula* Linnaeus Distribution

Common Blackbirds are highly adaptable to urban settings, where they adjust their song pitch and volume in response to city noise. They often sing at a higher pitch and louder volume in urban areas to overcome the background noise, which contrasts with the more nuanced, lower-volume song observed in quieter forest settings. These birds demonstrate remarkable behavioural plasticity, modulating their singing behaviour based on their immediate acoustic environment. For example, in noisy urban areas, blackbirds might sing at dawn or dusk when traffic noise is lower, thus maximizing the reach of their calls. Variations in blackbird songs are affected by the urban environment. Their song parameters, such as minimum and maximum frequencies, change along an urban gradient and their songs are modulated according to the level of ambient noise. The minimum average frequency of blackbird song notes differed among the three types of environmental areas sampled (urban, periurban, and rural). The minimum frequencies decreased along the urban gradient from noisy places in the city centre to rural areas. (Mendes)

Here are the average minimum frequencies for each area:

Urban	2277.24 ± 199.75 Hz
Periurban	2031 ± 100.49 Hz
Rural	1917.97 ± 123.97 Hz

There is a statistically significant differences between urban/periurban areas but not between periurban/rural ones. The same pattern was observed for maximum frequencies, which also decreased along the urban gradient:

Urban	3165.45 ± 340.48 Hz
Periurban	2799 ± 162.76 Hz
Rural	2657.08 ± 63.41 Hz

Significant variations were found between both urban/periurban areas and periurban/rural ones. Blackbirds adjust their song frequencies to reduce masking by ambient noise, particularly at low frequencies. The degree of this adjustment is correlated with the level of ambient noise in the environment. It is observed a high level of behavioural plasticity, adjusting their songs to better communicate in noisy urban environments. This adaptation may be critical for successful reproduction in noisy conditions.

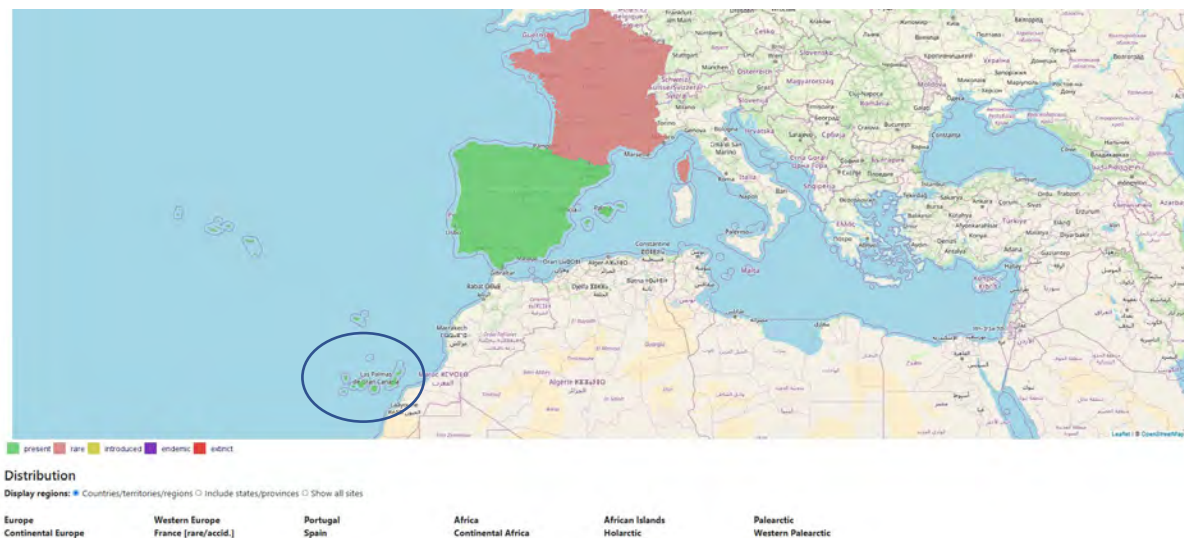
Messiaen was a dedicated ornithologist, deeply interested in birdsong. He even went on birdwatching trips to capture their sounds. Messiaen faced challenges in accurately transcribing blackbird songs due to their high pitch, speed, and complexity. He made musical compromises to adapt the blackbird songs to his own compositions, making them playable for instruments and fitting within the tonal system. He aimed to create an atmosphere of nature, rather than provide a literal translation of blackbird songs. (Hold) He focused on incorporating key

characteristics, such as motifs, intervals, and contrasts, rather than specific pitches. Messiaen's understanding of blackbirds evolved over time. Early on, he was less certain about his transcriptions. Later, he recognized the limitations and embraced a more nuanced approach, acknowledging the complexity of the bird's songs. While Messiaen attempted to be as accurate as possible, he made musical choices to adapt the birdsongs for his own creative purposes. (Lanooy)

The accuracy of his bird representations remains a subject of debate, with some musicologists arguing that he focused on capturing the essence of the birdsong rather than providing a literal translation. Overall, Messiaen's profound appreciation for the beauty and complexity of blackbird songs suggest that he sought a balance between accuracy and artistic freedom in his musical representations of these captivating sounds. On the other side Mâche is interested in zoömusicology, a field he helped to establish, which seeks to examine the musicality of animals beyond traditional human-centered perspectives. He uses the pied butcherbird as an example of how a species might exhibit a complex and deliberate use of sound that could be considered musical. François-Bernard Mâche sees the pied butcherbird as a collaborator in the creation of music. He's suggesting that “Birdsong may have a purpose beyond simple survival needs”. (Taylor)

The idea of music being solely a human construct is a limiting perspective. There may be a deeper connection between music and the natural world. Mâche views the pied butcherbird as a fellow artist, implying a connection between the human and the avian understanding of sound. Through a more philosophical view of music that goes beyond traditional definitions, Mâche seems to suggest that birdsong might be a form of musical expression, and that humans can learn from and collaborate with other species in our understanding of music. McGarry's approach to using the blackbird in his composition is to capture the bird's essential character while recognizing its inherent complexity and variable nature. He uses a combination of techniques, including granular synthesis, drones, and rhythmic patterns, to create a cohesive and emotive soundscape. (McGarry)

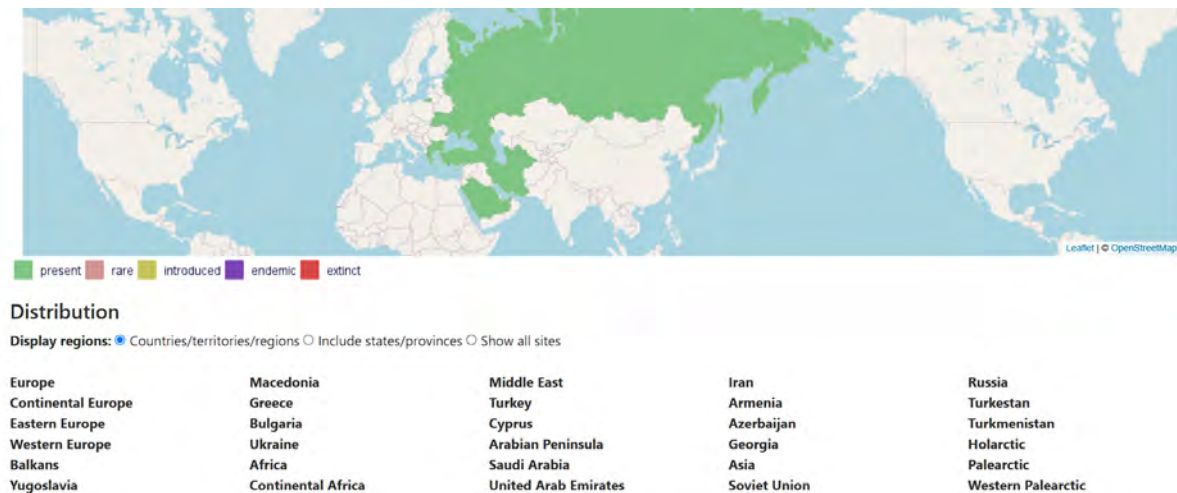
2.1. Blackbird space's song presentation



Turdus's merula cabreræ Distribution

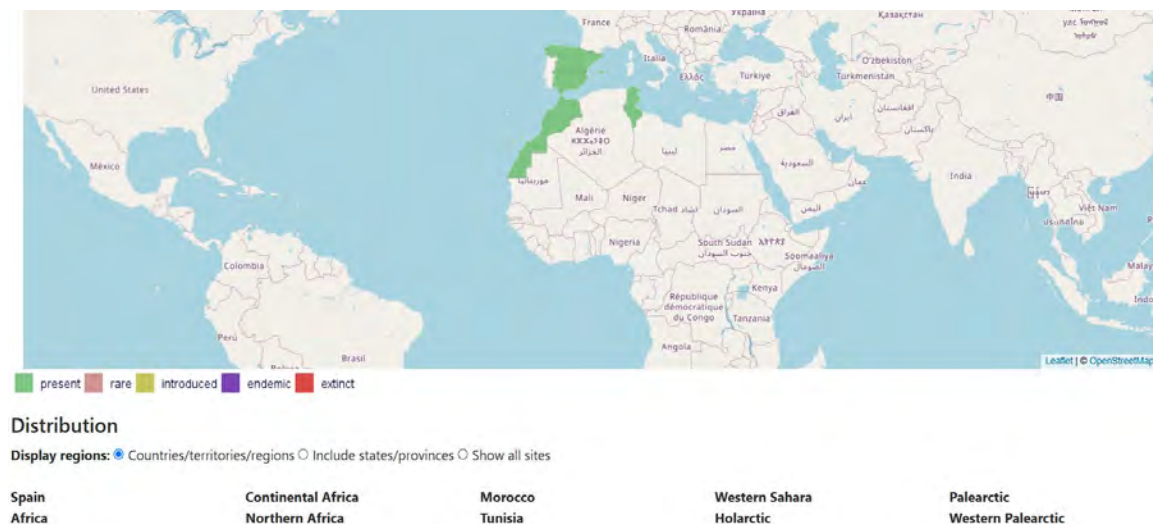
In this research we will deal with three subspecies of *Turdus merula*. The subspecies *Turdus merula cabreræ* is a variant of the Common Blackbird (*Turdus merula*), and it is endemic to the Canary Islands. This subspecies has evolved unique characteristics adapted to the particular environmental conditions of this Atlantic archipelago. *Turdus merula cabreræ* displays unique adaptations to island life, including subtle differences in appearance, behaviour, and song. Its limited range within the Canary Islands highlights its dependency on specific habitats, making conservation of these areas crucial for the subspecies' continued stability. The song may be less loud and shorter in length due to the more stable, isolated island territories, where competition for territory is not as intense as on the mainland. In addition, the structure of laurel forests may influence the pitch and tone of their calls to optimize sound transmission through dense vegetation. This subspecies is largely sedentary, rarely migrating due to the mild climate of the Canary Islands. Individual territories tend to be smaller and more stable

compared to mainland blackbirds, likely due to the relatively stable availability of food and lack of large-scale seasonal changes.



Turdus's merula aterrimus Distribution

Turdus merula aterrimus is a regional variant of the Common Blackbird (*Turdus merula*) and is found in SE Europe, W and N Turkey, Caucasus area, N Iran and adjacent S Turkmenistan. In quieter rural and forested settings, these birds sing with the typical flute-like quality of blackbirds, but in urban areas, they adapt by singing at higher pitches or louder volumes to be heard over ambient noise. This subspecies displays typical blackbird behaviours, including territoriality during the breeding season and a general adaptability to both natural and human-altered landscapes. They are less migratory than northern blackbird populations, often remaining resident in their territories year-round due to the milder winters in the Mediterranean region including areas like Crete, Rhodes, and coast of West Asia bordered by the Aegean Sea. *Turdus merula aterrimus* shows regional adaptations in terms of appearance and song characteristics while retaining the general behavioural flexibility and ecological adaptability of the Common Blackbird species. Its adaptability to diverse environments helps maintain its presence across the Mediterranean landscape.



Turdus's merula mauritanicus Distribution

Turdus merula mauritanicus is a subspecies of the Common Blackbird (*Turdus merula*) that is native to the northwestern regions of Africa, particularly in Morocco, Algeria, and Tunisia the song of this subspecies may be slightly shorter and more reserved than that of European populations, possibly due to the sparser vegetation and the need to avoid attracting predators in the open, dry landscapes. The song may also vary seasonally,

intensifying during breeding to attract mates and establish territories. Unlike migratory European blackbirds, *T. m. mauritanicus* is largely sedentary, often remaining in the same territories year-round, given North Africa's milder winters. This stability allows them to form well-defined territories in favourable habitats, with less need to compete or move seasonally. The population of *Turdus merula mauritanicus* is relatively stable, but it faces localized threats from habitat loss due to urban expansion, agriculture, and changes in water availability due to climate change. These pressures are most intense in areas where human activity intersects with the riparian zones and coastal scrublands they inhabit. Blackbird song serves multiple social functions, such as territory marking, mate attraction, and individual identity communication.

Parameters of the song convey information specific to blackbirds, including species identity, individuality, and behavioural states.

Motif and Twitter Parts: A typical blackbird song phrase consists of a *motif part* adapted for long-range communication and a *twitter part* for short-range interactions.

Phrasing: Each phrase is composed of sound figures, pauses, and specific durations that contribute to message coding.

Variation in Song Parameters: Key song parameters include duration of phrases, sound figure frequency ranges, amplitude, and cadence of delivery, with these parameters varying by individual and context (e.g., dawn vs. evening singing).

2.2. Measurement Techniques

Audio Visualize Analysis: The study employs audio visualizer to visualize frequency, rhythm, and pauses, revealing variations in sound figures within and between individuals. Blackbirds use consistent structures within certain limits for species recognition, while minor individual variations aid in identifying particular blackbirds. The motif's lower frequency and consistent amplitude make it effective for transmission through wooded habitats. The twitter part, often emitted close to other blackbirds, includes higher frequencies, which degrade over distance and prevent it from reaching far. (Smith)

3. Blackbird song: from motivic structure to improvisation

One of the most important elements that we want to examine is the element of improvisation. This characteristic of improvisation applies across various music genres, showcasing its universal importance. However, it is often most prominently associated with jazz music. The aim is to analyse the correlation of the blackbird song and its perception in a broader context concerning music improvisation, so as to understand the structures within which it operates. Music improvisation is an issue that neuroscientists are carefully investigating but also in combination with machine learning. Blackbirds have been well documented to exhibit dialects, with copying playing a major role in establishing similarities between neighbouring birds. (Lemon) New syllable types arise through modification of existing forms and are often presented in combinations and permutations peculiar to a locality. Dialects in blackbirds are often quite arbitrary, meaning that the distinction between different syllable classes is subjective. Improvisation of new syllables is a significant source of individual variation in blackbird songs, particularly for birds reared in isolation. Some individuals may develop new syllables that are similar to those in the wild, suggesting that improvisation can be influenced by innate predispositions. That process can be influenced by several factors, including the time at which a bird acquires its territory and its individual experience.

It's also possible for new syllables to be created through the combination of existing syllables in different sequences. Copying is a major factor in the development of blackbird dialects, with young birds learning from adults, particularly their parents. The copying process typically terminates with the development of motor patterns, meaning that birds are more open to influence during their first summer and the following spring. Copying, improvisation, and drift, contribute to the unique and diverse repertoires of blackbird songs across different localities. While there is a degree of conformity, the development of new song types and individual variation add to the complexity of blackbird song.

Also, through the process of improvisation, we find out how birds learn to sing. There is an attempt to map the learning of chicks and how we are led through the study of precocious brains to more complex ones such as that of humans. Young birds first memorize the songs of adult "tutors," usually during a critical period. This phase is purely auditory and involves forming an internal template of the song. Birds then enter a stage where they

practice their song, gradually refining it to match the memorized template through a process of vocal imitation and feedback. (Kirn) This phase includes sub-song, plastic song, and finally, crystallized song stages, where the song structure stabilizes. Central to the production and learning of song, the HVC (high vocal centre) projects to RA (robust nucleus of the arcopallium), which directly controls vocal muscle movements. This pathway coordinates the timing and patterning of song. Includes the brain regions Area X, DLM (dorsal lateral nucleus of the medial thalamus), and LMAN (lateral magnocellular nucleus of the nidopallium). The AFP is crucial for learning, enabling birds to refine their song by comparing vocal output to the internal song template. These pathways involve brain regions like the NCM (caudomedial nidopallium), important for song perception and template storage. New neurons are added to key areas like the HVC throughout life, particularly during periods of song learning and modification. Connections between neurons, especially in the AFP, undergo pruning as the song stabilizes. This refinement process is partly dependent on auditory feedback and experience. Gonadal steroids, such as testosterone, influence both the development and maintenance of the song control system, particularly during the breeding season, when song learning and vocal plasticity may be heightened. (Kirn)

4. Analysis of three models and comparative study - Methodology

The recordings were selected from Xeno-canto.org, where it was made sure that each example was of the subspecies of interest. For the extraction of durations and frequencies, the recordings were imported to Sonic Visualiser, with an added layer of sonogram (referred to as spectrogram). From there, the Measure tool was used to separate each phrase from the rest, each motif part from the twitter part and each sound figure from the other ones. The same tool was used to extract the frequency range of each part and the lowest and highest fundamental frequencies of the motif part, always keeping in mind that they are on the basis of the quality of the recordings. Also, this was the way to extract the duration of each phrase, part, sound figure and the respective pauses. The sonogram (Figure1) image below is a simplified version where only the frequency range of the phrase is shown as well as the segmentation of each sound figure and pause within the phrase. Each sound figure was separated by its visual representation and also by listening to the example.

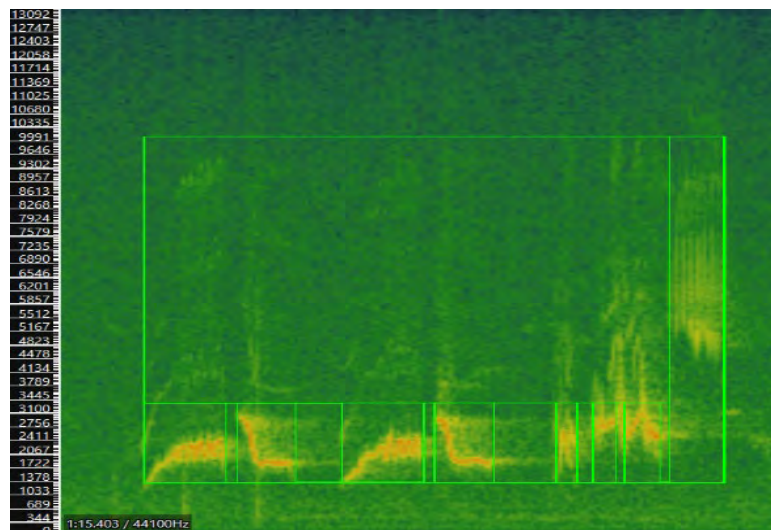


Figure 1. Sonogram by *Turdus merula aterrimus*-XC31679 phrase analysis

For the structural analysis (Figure 2), each phrase was categorised as A, B, C etc. mostly by the beginning of each motif part which is the most recognisable. (Dabelsteen) The following link is provided containing in detail the total analysis, charts and the data of the study of the three subspecies:

https://drive.google.com/drive/u/0/folders/10rBwLyJxX6vpnqX7KFBdTku_eBwiyxg

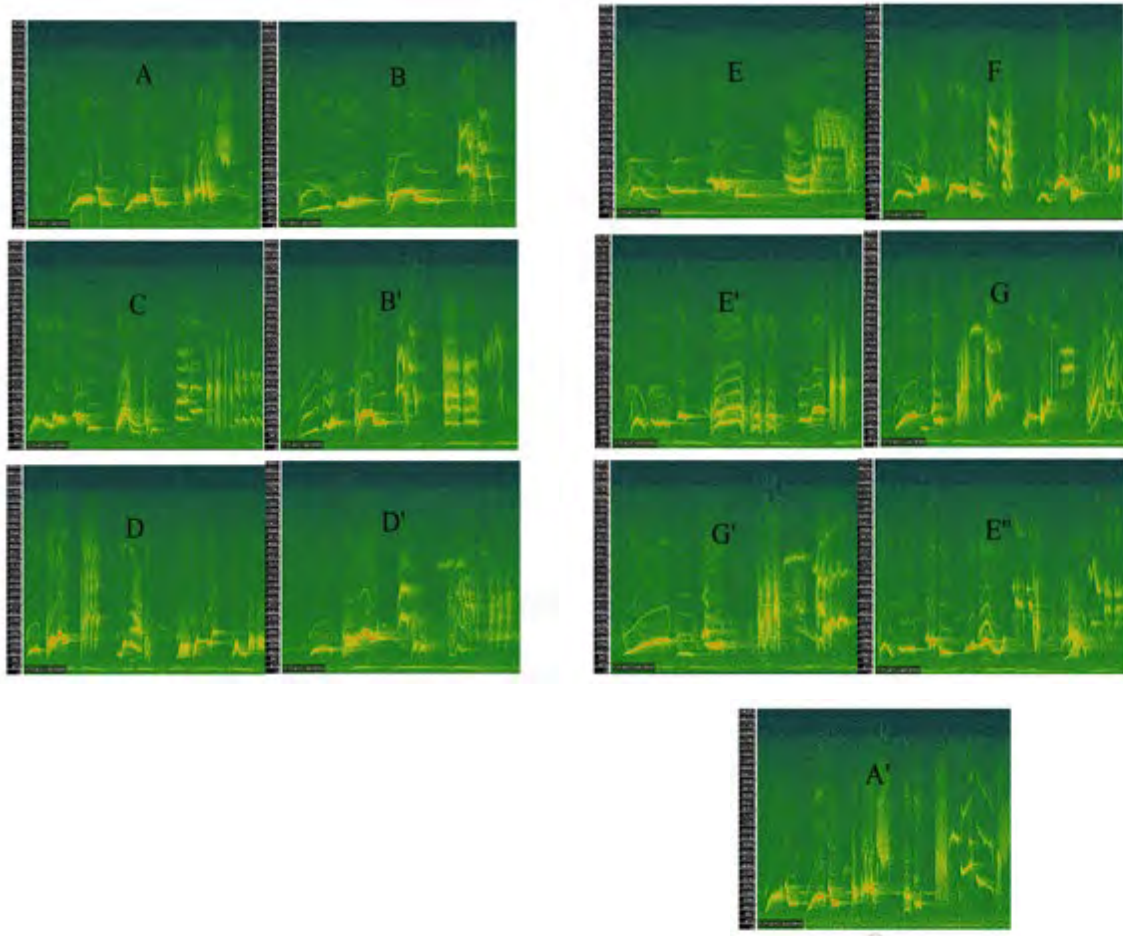


Figure 2. Structural analysis

On the structure analysis

In each recording there were phrases that kept coming back, always different or slightly different. From the analysed parts we can assume that the phrases below are the preferred motives from each recorded bird, but the length of the recordings lets us only to assume.

Transcriptions

Here (Figure 3) is an example of an A and A', in musical notation. Phrase 1 and phrase 13 from XC31679 *Turdus merula aterrimus*, where the 1st phrase appears again but extended.



Figure 3. Transcription in musical notation

5. Discussion

Blackbirds' phrases are not extensive but small, clear and clean. Through our study many future searches have emerged. We want to conduct field research by recording birds from the first day of chirping until termination in the same area. We aim to study the adaptability of blackbirds to city sounds and contrast them with the sounds we have analysed from the forests. Another research component is the song during the breeding seasons of the birds. Via that process we will find out how inventive and more richly improvisational males can be in their attempts to claim female birds. As far as the climate crisis is concerned, Rusty Blackbirds have shown significant declines in migration numbers and population stability due to several environmental and human-related factors.

Factors contributing to their reduced migration include habitat degradation in their breeding and wintering areas, loss of wetlands, increased mercury contamination in northern habitats, and direct mortality from efforts to control blackbird populations deemed nuisances. (Greenberg) This combination of ecological stressors has led to a decline in their traditional migration behaviour, making them less commonly observed in regions they used to frequent. Birds may stop migrating for several reasons, typically tied to environmental changes, evolutionary adaptations, and immediate survival needs. Sudden changes in climate, such as warmer winters, can make it feasible for birds to remain in breeding or wintering grounds year-round instead of undertaking energy-intensive migrations. If sufficient food resources are available year-round in one place, birds may opt to stay, saving energy that would have been spent on migration. Habitat loss along migratory routes can interrupt migration patterns. Birds unable to find suitable stopover habitats may be forced to shorten or abandon migration. Over time, populations may adapt to local conditions if migration is no longer advantageous, leading to a gradual shift in migratory behaviours. (Morganti)

Warmer temperatures can lead birds to migrate earlier or later than usual, disrupting their synchronization with food sources, like insects and flowers, that they depend on during migration. As climates shift, habitats suitable for many bird species may shrink or shift geographically. For instance, some northern or alpine bird species are losing habitat as temperatures warm, and certain southern or lowland species are expanding their ranges into previously cooler areas. Warmer temperatures can cause mismatches in the timing of food availability. For example, birds that feed on insects may arrive at their breeding grounds to find fewer insects if climate change has shifted the timing of insect hatches. (Desrochers) Extreme weather events like storms, droughts, and heatwaves can directly kill birds or make survival more difficult by increasing stress on resources like water and food. Changing temperatures and weather patterns can affect nesting success, either by influencing the timing of egg-laying or by impacting the survival rates of young birds through greater predation or food scarcity. Finally, it would be useful to check the possibility of analysing beyond the song of male birds the song of females that seems to be absent from the singing antecedent, with the ultimate aim of presenting a more feminist perspective on the song of blackbirds.

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EcoMuseum Zagori Soundscapes: Raising Awareness through Acoustic Community Interventions

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Abstract

EcoMuseum Zagori integrates Acoustic Ecology and sound practices to raise environmental awareness and preserve local heritage. Through the EchoLoci app, developed in the "Innovative Actions with Citizens" Greek Green Fund programme, EcoMuseum Zagori documents and promotes biodiversity on traditional livestock routes with community participation. The app records soundscapes, capturing the seasonal and ecological significance of pastoral routes, contributing to a digital soundmap that supports environmental education and cultural preservation. EchoLoci is utilized in two European projects: PONT (2023-2025), aimed at Egyptian vulture protection and traditional livestock farming, and the ACCTING Horizon Pilot Project, focused on pastoral route preservation. Through interactive apps, citizen science and participatory workshops, these initiatives engage local communities and decision-makers in wildlife conservation efforts. Soundscape analysis and workshops highlight biodiversity, with specific recording points in East Zagori's Liapi region. The project includes diverse activities, such as educating children on transhumance, a mobile photo exhibition and a soundscape composition by Dimitris Batsis, which will be presented in local art exhibitions. A documentary featuring "Video Portraits" of rural women also captures the intersection of natural inspiration and local craft. Looking ahead, EcoMuseum Zagori plans to expand EchoLoci's sound database, exploring Virtual and Augmented Reality applications to foster immersive environmental engagement. This initiative emphasizes sound as a vital element in ecological understanding, aiming to inspire sustainable practices and cultural heritage preservation in Zagori.

Keywords

EcoMuseum Zagori, Echoloci application, soundscapes, ecological sound art, citizen science

1. Introduction

Acoustic Ecology has emerged as a vital field in addressing ecological concerns, combining artistic and scientific practices to highlight the relationship between sound and the environment. EcoMuseum Zagori exemplifies this approach by using sound to raise environmental awareness while preserving local cultural heritage in the Zagori region of Greece (EcoMuseum Zagori, n.d.). The project, which is part of two European initiatives—PONT, focusing on the protection of the Egyptian vulture and traditional livestock farming, and ACCTING, aimed at preserving pastoral routes—relies heavily on the innovative *EchoLoci* platform. This soundscape platform records and preserves biodiversity with the active participation of local communities, helping to document the natural and cultural landscapes through sound. The primary aim of this research is to explore how soundscapes can be used as communication tools for environmental conservation, fostering engagement between local populations, decision-makers and the broader public. By focusing on the intersection of sound, biodiversity and cultural practices like transhumance, *EchoLoci* not only raises ecological awareness but also emphasises the importance of preserving both natural ecosystems and cultural traditions. The interdisciplinary nature of this approach positions sound as a powerful medium for understanding and promoting environmental sustainability, while the involvement of stakeholders in data collection creates a participatory framework that highlights the significance of both wildlife and local heritage.

2. Soundscapes, Biodiversity, Transhumance and Ecological Understanding

Soundscapes represent the total acoustic environment, composed of three primary elements: biophony (sounds of living organisms), geophony (natural non-living sounds like wind and water) and anthropophony (human-generated sounds). These elements combine to form a dynamic auditory landscape that offers critical ecological insights by reflecting the health and interactions within ecosystems (Farina, 2014, pp. 7-11; Sueur & Farina, 2015, p. 493). Biodiversity plays a vital role in shaping soundscapes, as the richness and variety of species contribute to a complex and vibrant acoustic environment, with sounds serving crucial functions such as mating, territorial defence, and predator alerts (Farina & Belgrano, 2004, pp. 5-17). Researchers use soundscapes to assess ecosystem health and track the influence of human-induced noise (Barber et al., 2010, pp. 180-189; Slabbekoorn & Ripmeester, 2008, pp. 72-83). Transhumance, the seasonal movement of livestock between different grazing grounds, has both ecological and acoustic impacts.

This traditional practice shapes landscapes by preventing ecological succession, promoting biodiversity through the maintenance of open environments, and subtly altering the soundscape by introducing the sounds of human activity and livestock (Mullet et al., 2017, pp. 332-349). As a result, transhumance reflects a balance between human practices and ecological diversity, making it an important factor in both cultural heritage and ecological preservation. Biodiversity is directly linked to the complexity of a soundscape. The presence of a diverse range of species enriches the biophony of an area, creating an acoustic environment that reflects the health of the ecosystem. A loss in biodiversity often results in a more monotonous soundscape, signalling potential ecological imbalances. The interplay between species through sound highlights the importance of biodiversity in maintaining ecosystem stability, particularly as species use acoustic signals for critical life functions such as reproduction and navigation (Farina & Belgrano, 2004, pp. 5-17). Ecological sound art offers a powerful means of interpreting and communicating the complexity of natural soundscapes, drawing attention to ecological issues like biodiversity loss and climate change. By capturing the interplay between biophony, geophony, and anthropophony, sound artists enable us to engage with the subtle and often overlooked acoustic signatures of ecosystems.

This emerging field of ecological sound art, which combines artistic expression with ecological concerns, makes the imperceptible audible—such as the gradual melting of glaciers—and provides an emotional, sensory connection to the environmental changes threatening biodiversity (Gilmurray, 2018, p. 140). Sound artists like Douglas Quin and Jana Winderen, through their work with oceanic recordings, offer audiences an immersive experience of climate change, facilitating a deeper ecological awareness (Whittaker et al., 2024, Article 106347). Through installations and performances, ecological sound art creates an ecological mode of listening—one that moves beyond individual sounds to grasp the broader interactions within ecosystems. This mode of listening highlights the interconnectedness of species and their environments, emphasising the urgency of environmental preservation by making the impacts of human activities, such as noise pollution, more tangible (Mullet et al., 2017, pp. 332-349).

Acoustic Ecology investigates how changes in soundscapes reveal broader environmental changes, particularly in the face of the climate crisis. Climate-induced shifts in habitat composition, species behaviours and acoustic niches indicate broader ecological disruptions. The increasing presence of technophony in natural environments not only disrupts species communication, impacting behaviours like mating and foraging, but also diminishes the natural complexity of soundscapes (Barber et al., 2010, pp. 180-189; Slabbekoorn & Ripmeester, 2008, pp. 72-83). Soundscapes serve as an important indicator of these shifts, providing insights into how species adapt—or fail to adapt—to environmental changes. Through ecological sound art, artists document these changes and help audiences connect to the climate crisis on a personal level. For instance, artworks like Katie Paterson's *Vatnajökull (the sound of)* and Max Eastley's *Glacial Soundscape* bring the real-time auditory experience of melting glaciers into gallery spaces, offering an immediate sensory link to otherwise distant environmental processes (Gilmurray, 2018, p. 39). These projects underscore the role of sound not only as an ecological phenomenon, but also as a tool for education and activism, helping to convey the scale and urgency of the climate crisis.

3. Overview of EcoMuseum Zagori

EcoMuseum Zagori, established in 2014, is a social cooperative enterprise dedicated to the preservation, management and sustainable development of the cultural and natural heritage of the Zagori region in Epirus, Greece. The museum operates based on the principle that local monuments remain "in situ," preserving them

as living witnesses of a specific era. Through educational and experiential programs, the EcoMuseum provides visitors with opportunities to learn about various aspects of the area's social life, production processes and its cultural and natural history. By creating a direct connection between the natural environment and the local community, the EcoMuseum promotes a deeper understanding of how the region's heritage shapes both the past and present identities of the area.

A unique aspect of the EcoMuseum Zagori is its role as a bridge between the local community and visitors. The museum functions as a cultural and educational centre, with the local community actively involved in transmitting traditional knowledge to visitors. Visitors, in turn, participate in various educational programs, seminars and workshops designed to enhance their understanding of the region's rich cultural and ecological legacy. The EcoMuseum is also committed to the sustainable management of resources and the promotion of activities that ensure the survival of local traditions and crafts, while advancing social cohesion and environmental protection.

3.1. Mission and Goals

EcoMuseum Zagori's mission is centred around preserving the region's rich natural and cultural heritage while supporting local development through a variety of sustainable actions. The museum's goals are multifaceted and include:

- **Cultural Development:** Promoting local identity by preserving and transmitting traditions, knowledge and craftsmanship to future generations through educational and community-based activities.
- **Social Development:** Offering employment opportunities to the local population, particularly in the areas of traditional crafts, cultural preservation and ecological conservation, thereby encouraging social inclusion and community engagement.
- **Environmental Protection:** Organising scientific conferences, mapping thematic hiking paths and raising awareness about local biodiversity and ecosystem services, aiming to protect and promote the region's natural assets.
- **Economic Development:** Supporting sustainable tourism by promoting cultural tourism and geotourism, positioning Zagori as an international destination for eco-friendly travel experiences.
- **Demographic Growth:** Contributing to the retention of the local population by creating job opportunities, attracting new inhabitants and improving the quality of life in the region.

The EcoMuseum also actively participates in European programs and initiatives aimed at fostering sustainable development, education and cultural accessibility.

4. Overview of European Projects: PONT and ACCTING

The EcoMuseum Zagori is a key player in various European initiatives, particularly in projects that align with its mission of preserving cultural and natural heritage. Two of the most notable projects the EcoMuseum is involved in are PONT and ACCTING:

PONT (Prespa Ohrid Nature Trust, 2023-2025): This project focuses on the protection of the endangered Egyptian vulture and the preservation of traditional livestock farming in the Epirus region. The EcoMuseum collaborates with local livestock breeders to reduce the use of illegal poison baits, a practice that threatens both the vultures and livestock guardian dogs. By promoting sustainable practices such as the use of predator deterrents, the project supports biodiversity conservation while highlighting the importance of maintaining traditional farming methods, including transhumance.

ACCTING (Horizon Pilot Project): This project, under the Horizon 2020 program, focuses on promoting biodiversity conservation and raising awareness about the impacts of climate change on ecosystems. Through the "Echoversity" initiative, the EcoMuseum leads participatory workshops and citizen science campaigns aimed at recording and preserving biodiversity in the region. The project encourages public involvement in collecting data on biodiversity changes and contributes to crafting evidence-based solutions for conservation efforts.

5. Role of *EchoLoci* in Preserving Cultural and Natural Heritage

A cornerstone of the EcoMuseum's efforts to protect and preserve the cultural and natural heritage of Zagori is the *EchoLoci* project (EchoLoci, n.d.). Developed as part of a previous EcoMuseum initiative funded by the Greek Green Fund, *EchoLoci* uses soundscape recordings and citizen participation to document and conserve biodiversity along the region's pastoral routes. This project underscores the importance of sound as a tool for environmental awareness and heritage preservation.

EchoLoci captures the unique acoustic environments of Zagori's transhumance routes—traditional paths used by nomadic shepherds—providing valuable insights into the region's biodiversity. Through mobile laboratories, local communities and scientists collaborate to record and analyse sounds from these landscapes, creating a comprehensive database of the area's natural soundscapes. These recordings offer a sensory connection to the natural world, helping to preserve the cultural practice of transhumance and its critical role in maintaining local biodiversity.

The application also facilitates educational programs, engaging children and adults in activities related to transhumance, biodiversity and Acoustic Ecology. The recordings gathered through *EchoLoci* are used in sound art compositions and experimental video artworks, further enhancing public engagement with environmental conservation. Additionally, the data collected through the project contributes to long-term conservation efforts by creating a rich soundmap of the region, which can be used for future research and as a tool for raising awareness about the importance of preserving both cultural traditions and natural resources.

5.1. Methodology

To develop an integrated understanding of the unique ecological and cultural landscape of Zagori, the EcoMuseum employs a methodology grounded in participatory science and community engagement. Through a “bottom-up” approach, local communities play an active role in shaping the museum's initiatives, particularly in biodiversity conservation and cultural heritage preservation. This methodological framework not only encourages community engagement but also creates a sustainable model for preserving both the natural and cultural heritage of the region.

For ACCTING, the methodological approach involved a series of targeted activities designed to comprehensively document and understand the biodiversity and cultural heritage of Zagori. Citizen science activities, such as participatory sound mapping and geographic logging, allow residents and scientists to collaboratively document natural and cultural landmarks along traditional pastoral routes. The data collected enriches the biodiversity database and strengthens the connection between the community and their environment, reinforcing the cultural identity of Zagori.

Although we did not conduct fully seasonal recordings in Liapi, two distinct recordings were performed: one in May to establish an initial understanding of the path's flora and fauna, and the other in July to capture seasonal variation. Additionally, the primary methodological framework included the following actions:

1. **Recording and Mapping of Biodiversity:** Conducted through Bio-Blitz workshops which are a form of citizen science where participants work together to identify and record as many species as possible within a set area and time and Sound Walks, these activities involve participants in identifying and documenting local species. Seasonal sound diversity is mapped across five spatial points in East Zagori to analyse the impact of pastoral practices on the soundscape, providing insights into biodiversity changes throughout the year.
2. **Mapping of Ecosystem Services:** By identifying key ecosystem services on-site, we gain a clearer understanding of how these natural resources support the local environment and community.
3. **Cultural Identity Documentation of Nomadic Pastoralists:** This component involves recording the traditional cultural practices and lifestyle of local pastoralists, emphasising their role in conservation and cultural shaping.
4. **Educational Program for Children:** Aimed at connecting younger generations to the paths of transhumance and the region's biodiversity, this program educates children about ecological principles and cultural heritage.

5. Mobile Photo Exhibition: Inspired by the region's biodiversity and its connection to transhumance routes, this exhibition raises public awareness of the local ecosystem through visual storytelling.
6. Creation of Artisan Products: Local pastoral women create products inspired by regional biodiversity, using natural and traditional processes. This initiative highlights the interdependence between local culture and ecology while promoting sustainable practices.

Furthermore, under the PONT project proposal, we plan for full seasonal recordings at Elafotopos in Western Zagori, starting in fall 2025, to capture the soundscape across all four seasons. This will provide a more comprehensive understanding of seasonal biodiversity changes in the region, offering deeper insights into the ecological impact of pastoral and seasonal practices.

6. *EchoLoci*: Citizen Science and Acoustic Technology for Biodiversity Preservation

EchoLoci is a project focused on recording and conserving biodiversity along the pastoral routes of Zagori. Through sound and visual documentation, *EchoLoci* involves local citizens in collaborative efforts to preserve Zagori's rich natural and cultural heritage. This approach ensures that local residents contribute actively to the conservation of endangered species and habitats, supporting both ecological and cultural continuity. By promoting awareness of the region's nomadic pastoral practices, *EchoLoci* helps protect not only biodiversity but also the cultural memory and identity associated with these landscapes, reinforcing values of social cohesion, equity, and shared responsibility.

The development of the *EchoLoci* application was inspired by the functionality of the Echoes app (n.d.), which served as a reference model. With Echoes as an inspiration, the *EchoLoci* platform enables users to geolocate soundscapes, images, and narratives, making it an intuitive and engaging tool for documenting biodiversity. This structure allows contributors to easily upload, organise, and share multimedia content related to Zagori's ecosystems and pastoral heritage, enriching the platform's value for research and cultural preservation.

Citizen involvement is fundamental to *EchoLoci*, engaging local residents as active contributors to biodiversity monitoring. Through mobile laboratories, scientists and citizens collaborate to record, analyse, and interpret the sounds and images of Zagori's pastures. This process highlights the essential role of transhumant pastoralists in maintaining ecological balance, while also creating a comprehensive archive of the region's natural soundscapes. By combining scientific monitoring with community participation, *EchoLoci* offers a rigorous and collaborative model for environmental conservation.

7. Interdisciplinary Awareness-Raising Activities

In the framework of the ACCTING project, several innovative awareness-raising activities and artistic interventions have been implemented, aligning with the broader goals of the EcoMuseum Zagori. These initiatives serve to both document and celebrate the unique biodiversity and cultural heritage of the Zagori region, with a particular emphasis on the role of women in environmental conservation efforts and the preservation of local traditions.

One of the primary methodologies adopted by the EcoMuseum Zagori involves soundwalks, where participants explore the natural soundscape of villages like Ano Pedina. For example, on the 11th of August, a soundwalk through Ano Pedina allowed participants to immerse themselves in the acoustic environment, intending to create a deeper connection to the area's natural and cultural landscape. This experience was paired with *She Moves Mountains*, a storytelling and live art session by a local artist, capturing the collective history and cultural essence of Zagori on canvas. These collaborative soundwalks not only map the sonic diversity but also engage the community in preserving the intangible elements of cultural identity, bridging modern conservation techniques with traditional knowledge.

The project has emphasised community involvement through workshops designed to document both natural and cultural heritage. Bio-Blitz workshops and participatory mapping initiatives have allowed community members to actively engage in identifying and recording local biodiversity. Through these activities, participants contribute to a shared database, enriching both local and scientific understandings of the ecosystem. These efforts resonate with the broader ACCTING goals, particularly in promoting the role of pastoral practices in biodiversity conservation and sustaining cultural identity.

In collaboration with local artisans, the EcoMuseum has curated a mobile photography exhibition titled *Weaving Networks*, showcased in Ano Pedina, Ioannina and Konitsa. This exhibition highlights the intersection of art, ecology and community engagement, focusing on the cultural significance of wool as a medium for connection among women and an emblem of the region’s pastoral heritage. Opening on September 29 at Archontiko Misios in Ioannina, the exhibition featured guided tours, presentations and a screening of *The Weavers*, a documentary by Dimitris Koutsiambasakos. In Konitsa, from October 18-28, the exhibition continued to showcase the importance of wool and its sustainable use, promoting a creative, eco-conscious approach to preserving traditional crafts and local biodiversity.

The soundscape composition activities integrate local ecological data, focusing on the dynamic acoustic characteristics of transhumance routes. Soundscape recordings are structured to reflect seasonal changes, highlighting the distinct sounds of biodiversity and human interaction with the environment. By coordinating these soundwalks and composing experimental soundscapes, the EcoMuseum offers audiences the opportunity to experience the interconnectedness of species, habitats and cultural practices. This approach encourages a new level of ecological awareness and sustainable practices among both residents and visitors.

Integrating diverse fields like acoustic ecology, cultural studies, and participatory science, the EcoMuseum's approach to the Echoversity project is inherently interdisciplinary. The aim is to transform soundscapes into communication tools, bringing attention to environmental changes and the value of traditional pastoral practices. Through sound-based activities and exhibitions, the project emphasises the interdependence of cultural heritage and environmental conservation, allowing diverse stakeholders—including scientists, local artisans and policymakers—to collaborate on preserving Zagori's ecological and cultural wealth.

8. Soundscape Composition and Experimental Video Artwork

Liapi is a soundscape composition made by the author, featuring field recordings from five key locations in East Zagori’s Liapi region. Showcasing the area’s rich biodiversity through recordings made in spring and summer, *Liapi* is part of the EcoMuseum Zagori’s broader initiative to raise ecological awareness and document natural soundscapes in collaboration with the local community. The acoustic signature of Zagori’s pastoral routes is captured in *Liapi* through soundwalks and selected recordings. The composition was featured in an experimental video artwork by filmmaker and multimedia artist Arianna Spyrou, exhibited across three Echoversity art exhibitions in Ioannina, Zagori and Konitsa. This artwork blends the *Liapi* soundscape with visuals that draw on the unique natural and cultural heritage of Zagori, immersing audiences in the region’s soundscape. Additionally, a four-minute documentary titled *Video Portraits* presents rural women engaged in traditional felting, whose craft reflects their connection to biodiversity and the surrounding environment. Thematically, *Liapi* explores the dynamic interactions between natural and anthropogenic soundscapes, engaging with principles of Acoustic Ecology and Soundscape analysis. In three unfolding movements, it captures the flow of groundwater, the nightingales' forest communication, a sudden chase as shepherd’s dogs ward off a wolf and the resonance from the bells worn by goats returning from grazing. Through these transitions, *Liapi* highlights the region’s biodiversity, aiming to offer audiences a sensory bridge to the natural world.

9. Discussion

In the context of *EchoLoc*i and Acoustic Ecology, narrative issues refer to the ways stories and experiences surrounding environmental and ecological concerns are communicated and understood by both local communities and broader audiences. The climate crisis has generated multiple narratives, often framed in scientific, political and emotional terms. However, these narratives can sometimes overlook or diminish the cultural and lived experiences of those directly connected to the land and ecosystems. *EchoLoc*i addresses this gap by using sound art as a tool to reframe these stories, grounding them in the acoustic space—the physical environment from which sound emanates, encompassing both human and non-human sounds. In this project, soundscapes become a medium for telling the stories of biodiversity, human interaction with the environment and the ongoing impact of climate change on ecosystems. By capturing and preserving these sounds, *EchoLoc*i creates an immersive, experiential narrative that moves beyond traditional textual or visual storytelling, giving voice to the non-human elements of the landscape.

For example, the inclusion of seasonal sound recordings in pastoral regions allows listeners to hear the changes in biodiversity and animal migrations. These audio recordings serve as a narrative device, illustrating the

interconnectedness of species, habitats and human agricultural practices. By using sound to convey these stories, *EchoLoci* provides a narrative layer that connects environmental data with cultural memory, enabling local communities and wider audiences to experience the ecological changes in real-time, which is particularly important in raising awareness and fostering emotional connections to conservation efforts.

The concept of using natural soundscapes as an element for creating a future database is rooted in the interdisciplinary research fields of Bioacoustics and Ecoacoustics. Ecoacoustics, a branch of Acoustic Ecology, studies the relationship between natural sounds and the environment, offering insights into biodiversity and ecosystem health (Farina & Pieretti, 2014, pp. 321–328). Natural soundscapes—a collection of sounds from both biotic sources (living organisms) and abiotic sources (non-living elements like wind or water)—serve as acoustic signatures of ecosystems. These signatures provide critical information about species diversity, habitat health and the impact of human activities such as agriculture or urbanisation on the environment (Turlington et al., 2024, Article 112388; Pijanowski et al., 2011, pp. 203–216).

EchoLoci’s soundscapes form the foundation for a comprehensive, participatory database that captures these unique acoustic environments. With the help of participatory workshops, sessions where local communities engage in environmental sound recording and analysis, citizen scientists and stakeholders actively contribute recordings from different geographic areas, such as livestock routes or conservation zones. These data, represented as a soundmap—a geographic visualisation of sound recordings—illustrate spatial and temporal patterns in biodiversity across the landscape. This dynamic soundmap is further enhanced by layering other environmental information, like vegetation cover, animal sightings, or climate data, forming a multimodal database. This database not only archives biodiversity but also serves as a research tool for monitoring ecosystem health over time, allowing researchers to observe ecological patterns and assess biodiversity resilience and adaptability under environmental stressors (Farina & Pieretti, 2014, pp. 321–328).

In the future, these soundscapes could be integrated into a Virtual and Augmented Reality framework, enabling researchers, policymakers and the general public to experience ecosystems in immersive environments. By hearing the actual sounds of species, weather patterns and human activity, users can gain deeper insights into the complex interactions within ecosystems. This participatory database would become essential for tracking shifts in biodiversity conservation, which is the protection and management of biological diversity, including the variety of species and ecosystems within a particular region. Such conservation efforts address concerns like species migration due to climate change, loss of natural habitats, or the success of conservation measures (Sueur & Farina, 2015, pp. 493–502).

The natural soundscapes collected by EchoLoci not only document current biodiversity, but also form a long-term ecological record, essential for future studies in both Acoustic Ecology and conservation science. This approach corresponds to emerging trends in Ecoacoustics research, where sound data are increasingly being used to measure ecological change, detect endangered species, and assess the impact of climate change on ecosystems (Gilmurray, 2018 pp. 40-52). By establishing soundscapes as a core part of conservation databases, EchoLoci paves the way for more comprehensive environmental research and public engagement, positioning sound as both an archival and educational tool in ecological preservation efforts.

10. Conclusion

EcoMuseum Zagori, through the EchoLoci project, has demonstrated the utilisation of Acoustic Ecology as a multidisciplinary approach to conservation. EchoLoci’s methodology intertwines environmental science and cultural heritage by documenting natural soundscapes, transhumant pastoral practices and the region’s biodiversity. This approach has not only raised environmental awareness but has also reinforced the connection between the local community and their heritage, embodying a participatory framework that empowers the residents of Zagori to actively contribute to the preservation of their environment.

As part of a broader vision, the continued use of EchoLoci proposes natural soundscapes as foundational elements for a large-scale, immersive database of regional biodiversity and cultural landscapes. This initiative, envisioned to be delivered in a Virtual and Augmented Reality framework, will enable future users—researchers, policymakers and the public—to experience the ecosystem in a profound and interactive manner. This immersive experience will underscore the dynamic interplay between sound and environment, encouraging a richer understanding of Zagori’s ecosystems while amplifying the EcoMuseum’s capacity to promote sustainable practices through innovative artistic expression.

EchoLocī’s approach aligns with the EcoMuseum’s mission to ensure that both the cultural and ecological heritage of Zagori is preserved and celebrated. By emphasising seasonal sound recordings, traditional pastoral routes, and community-driven conservation, the project contributes to a deeper understanding of biodiversity and ecosystem health. As these soundscapes accumulate into a comprehensive ecological record, EchoLocī sets a promising foundation for interdisciplinary conservation, where natural sounds become essential data points in tracking ecological changes over time.

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VLN_temp project: Music creation for violin and live electronics using sound sonification techniques to reflect global temperature changes

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Abstract

This paper aims, through the composition of a musical work for violin and live electronics, to depict the changes in the global average surface temperature over recent decades using sonification techniques combined with synthetic methods. The composition seeks to highlight critical ecological issues, specifically the issue of climate change, which poses a significant global challenge. To enhance the work, unique temperature data mapping techniques will be used, as well as synthetic processes that enable real-time sound processing of the violin, utilizing multiple effects created in Max/MSP. The contribution of human performance, which adds emotional value to the execution, can help in understanding the data and, consequently, emphasize the environmental issue of climate change. The overall project could be considered part of the framework of ecological sound art, a rapidly evolving field over the past twenty years. It emerges from the collaboration of scientists and artists who combine knowledge of acoustic ecology with creative practices to highlight the sonic expression of environmental data. Through this interdisciplinary approach, there is an effort to raise public awareness about the impacts of the climate crisis, offering an innovative auditory experience that merges scientific information with artistic expression, thus enhancing the interaction between art and science.

Keywords

Climate change, ecological art, interactive art, sound sonification, global temperature variation

1. Introduction

The environmental crisis, driven by human activity and resource overconsumption, threatens the planet's balance and the well-being of its species. The need for sustainable relationships with the environment is urgent, as communication of scientific findings to the public remains inadequate. Sound art can serve as a powerful tool for raising awareness of climate change, combining science and art. Data sonification, which translates data into sound responses, highlights artistic value and allows for a deeper understanding of environmental issues. The "VLN_temp project" explores the music composition influenced by temperature data, combining live violin performance with sonification. The research examines the sonic characteristics of musical representations of temperature data and how art can contribute to climate change awareness, focusing on practical and theoretical approaches that merge science and art.

2. Eco-Art and Interactive Music

2.1. Eco-Art: Bridging Sound and Environmental Consciousness

Ecological art focuses on expressing environmental issues, either through the form or content of the works. Many artists, in collaboration with scientists, create pieces aimed at raising public awareness of the environmental

crisis. Art is considered to contribute to the understanding of science and the promotion of creative thinking. Particularly in music, ecological art incorporates natural sounds and soundscapes to highlight the need to protect the environment and preserve the species inhabiting the planet. Techniques such as Soundwalking, Field Recording, and Sonification are used to compose musical works that connect the audience with the environment through listening. This relatively new genre of music composition is called environmental and ecological music. A reference of ecological music composition is Douglas Quin's *FATHOM* (2010), which consists of recordings of Arctic and Antarctic ice, aiming to reveal the underwater sonic dimension of these areas. Another reference is *Amhrán na mBeach* (2014) by the duo Softday, a sound piece exploring bee disturbance, featuring eight-channel recordings from inside a beehive, as well as a sound composition synchronized with the sounds produced by the bees. *Atmospherics/Weather Works* (2003) by Andrea Polli and Glenn Van Knowe provides sonic representations of the destructive storms "President's Day Snowstorm, 1979" and "Hurricane Bob, 1991" in New York. In the process of sound representation, the storm intensity data was mapped to five pitch heights, and these variables were used as filters for listening within a specific range.

2.2. Interactive Music and Ecology: Connecting Humans and Ecosystems through Sound and Technology

Interactive music is a form of musical creation influenced by human actions, combined with the electronic processing of these actions through an interactive system, resulting in a unique sonic output each time. In interactive music works, the performer can be either a musician or vocalist or the audience itself, actively participating through physical interaction with the system. In recent years, the element of interaction in ecological and environmental music composition has been extensively utilized to enhance ecological awareness, connecting people to their ecosystems. In the works mentioned below, the use of ecoacoustic data and interactive elements in music highlights the ability of music to convey ecological messages. *Iceprints* (2010) by Matthew Burtner is an interactive piece for piano and electronics based on ecoacoustic data from hydrophones beneath Arctic ice, as well as a graph depicting 40 years of ice extent changes. The recordings are played back through a surround system, giving the audience the feeling of being beneath the ice. The pianist plays in the lower octaves, symbolizing the melting ice. Burtner provides instructions for using the data, allowing the performer to use the piano as a measuring tool, transforming information into sound. The opera *Auksalaq* (2012), by Matthew Burtner and Scott Deal, is also a composition of interactive ecological music. It includes elements of ecoacoustic composition and translates data from the natural environment into sound, while allowing audience interaction through the NOMADS app. Participants symbolize melting ice droplets, with their sound increasing as more individuals join, accompanied by visual representation during the performance. The final reference will be the work *Heatwood* (2014), an interactive sound installation by Andrian Newton, designed specifically for the South Dorset Ridgeway Forest in England. This work addresses the wood disease affecting the local trees by recording their internal vibrations through sensors. The resulting sounds create audible experiences that change based on the movements of tree visitors, with sensors detecting these interactions. The project VLN_temp is a hybrid composition model that incorporates violin performance and electronic sound processing from an interactive system, inspired by average temperature change data from recent decades compared to ground temperatures from 1901 to 2000.

2.3. Auditory Display and Sonification of Temperature in VLN_temp project

Auditory Display and Sonification are two important processes concerning the implementation of the VLN_temp project. The first term, Auditory Display, refers to the use of sound as a medium for representing data or transmitting information. This term encompasses all the parameters of a human-machine interaction system, such as the installation of speakers, the manner in which the interaction will take place, and all the technical processes required for the collection, calculation, and processing of data to be rendered in the form of sound. The second term, Sonification, is integrated within the first term and specifically refers to the technical process by which sound is produced in response to data.

The first stage of the process was to collect temperature data, which was retrieved from the National Oceanic and Atmospheric Administration (NOAA), a scientific agency within the U.S. Department of Commerce. NOAA is responsible for the conditions of the oceans, atmosphere, and the broader environment. Specifically, the data includes global average land temperatures from January 1980 to April 2024, measured on a monthly time scale. These values are calculated in relation to the average temperature of the 1901-2000 period and presented in the following graph:

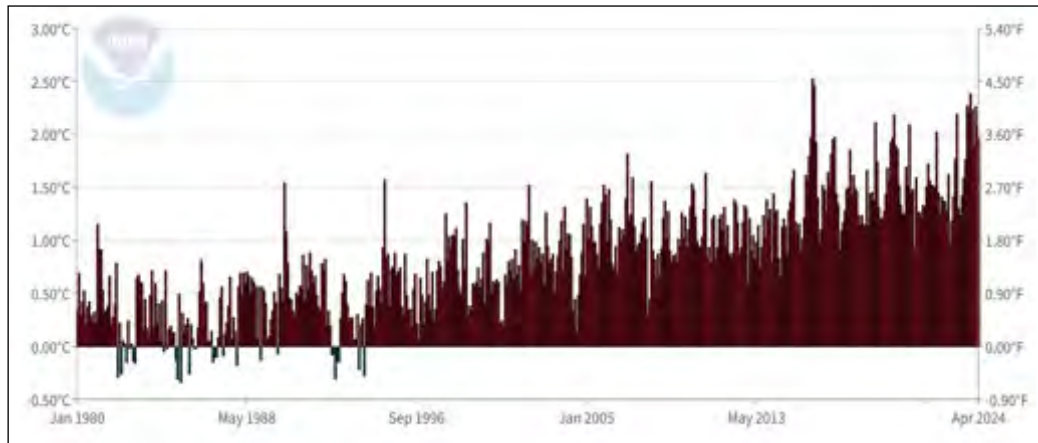


Figure 8. Temperature changes relative to 1901-2000

The following stage involved representing the temperature data as sound. This began with the recording of short violin samples using various techniques on the instrument. The improvisation emerged either by reading and interpreting the chart as a graphic score from left to right or by interpreting it based on the overall impression of the visual representation. Subsequently, each temperature value in °C from the chart was mapped to notes according to the MIDI protocol. The mapping process was based on the violin's range:

Note	G3	G#3	A3	A#3	B3	C4	C#4	D4	D#4	E4	F4	F#4
Midi-ET	55	56	57	58	59	60	61	62	63	64	65	66
°C	-0.5	-0.4	-0.3	-0.2	-0.1	0	+0.1	+0.2	+0.3	+0.4	+0.5	+0.6
Note	G4	G#4	A4	A#4	B4	C5	C#5	D5	D#5	E5	F5	F#5
Midi-ET	67	68	69	70	71	72	73	74	75	76	77	78
°C	+0.7	+0.8	+0.9	+1.0	+1.1	+1.2	+1.3	+1.4	+1.5	+1.6	+1.7	+1.8
Note	G5	G#5	A5	A#5	B5	C6	C#6	D6	D#6	E6	F6	F#6
Midi-ET	79	80	81	82	83	84	85	86	87	88	89	90
°C	+1.9	+2.0	+2.1	+2.2	+2.3	+2.4	+2.5	+2.6	+2.7	+2.8	+2.9	+3.0

Table 3. Mapping

The purpose of this mapping was to establish an interactive setup between the performer and a system created in Max/MSP. This system identifies specific pitches played on the violin in real time and, depending on the performer's input, can adjust the resulting sound accordingly.

3. The project VLN_temp

The central form of the project consists of two parts. In both parts, data is used as the primary inspiration, either through recordings or through mapping, as well as material that arises from the interaction of the live performance of the violin with the accompanying sound composition.

3.1. Representing Thermal aberrations

Thermal Aberrations is the first part of the project "VLN_temp". The sound produced by the performance of the violin, along with the live processing using effects created in the Max/MSP program, gains increasing complexity in relation to the time periods when the most significant temperature changes occur on the Earth's surface.

The utilization of time points was achieved by mapping the months to seconds from January 1998 to April 2024. During this period, the months with the most significant fluctuations correspond to seconds in the project where

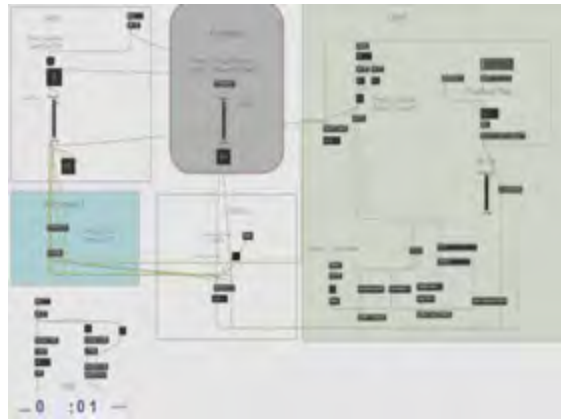


Figure 4. Heatwave habits patch

The same material from the short recordings was used to create the tape. In this case, the samples were modified using the digital audio workstation software, Reaper. The blending of the processed samples was accomplished using the violin, which also employed effects like pitch shifting and multiple delays. Toward the end of the piece, improvisation occurs over loops. The violinist has the ability to manipulate the sound via a MIDI controller with pads. The performer can start and stop the playback of the tape, adjust the pitch shifting of the violin, and create repetitions, all while following the score of the piece and a timer. In terms of interpretation, Heatwave Habits follows a linear progression. Its structure emerged experimentally and aesthetically. During the processing stage, there was a deliberate effort to approach sounds like fire on wood, the sound of helicopter blades, the sensation of high temperatures, and the feeling of fire. The colors and phrases created by the violin between the segments of the tape respond to the data of climate change. Throughout this section, the live performance of the violin primarily takes the leading role, while the tape serves as a musical backdrop, except for certain moments where the roles switch for a few seconds. From a different perspective, an effort is made to maintain a beginning, middle, and end, with climaxes in between.

VLN temp project score:

https://drive.google.com/drive/folders/1U0TPon9X10WmeZtGbn7iyYU3q6tIK5AD?usp=drive_link

4. Discussion

The creation of the project aims to awaken the audience to profound social issues, such as climate change, by using scientific data. Creating music with artistic and emotional value through the use of data poses a challenge, as temperature data are derived from natural phenomena. Nevertheless, they represent a numerical series that lacks the emotional element. The human contribution through the performance of the violin seeks to give artistic substance to the data through musical expression, thereby aiding in the understanding of this data.

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A watercolor illustration of a dark bird perched on a branch. The bird is dark-colored with a white patch around its eye and a long, pointed beak. It is perched on a thin, light-colored branch that runs diagonally across the frame. The background is a soft, light-colored wash with some darker, textured areas suggesting foliage or a natural environment. The overall style is artistic and painterly.

Acoustic Ecology in education

The notion of soundscape in Architectural education; The case of two short design assessments in the studio

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Abstract

This research concerns the presentation and comparison of two short design assessments in the architectural studio concerning sound and Acoustic Ecology that took place in two different academic years and two different students' groups, March 2021 and March 2023, involving a non-specialist audience in sound issues, such as 6th semester students of architecture. The evaluation of the projects highlighted the need to simplify standardized theory in order to communicate key concepts of soundscape theory and acoustics. However, the intense interest of the participants, mainly due to the use of equipment and software for processing and reproducing soundscapes, was very interesting. The use of Soundscape maps and graphic scores as an alternative way of architectural representation was decisive, so as to expand the constraints of traditional architectural visualization.

Keywords

Architecture educational practices, soundscape educational practices, architectural education, non-specialist audience in sound issues, sound and design tools, graphic scores

1. Introduction

This paper concerns an approach to educational practices concerning Architecture and Soundscape study and design. The two approaches, studied within the two studio iterations, are not directly relatable to each other but offer an interesting glimpse into the variety of approaches to the two subject matters. Each student's unique background was vital due to the use of sound and image manipulation tools, defining the outcome of each project. Each proposal had to be prepared within two hours, presented to the class and then discussed amongst every participant.

2. First academic module

The first academic assessment (part of the course of Architectural Design and New Technologies II, 6th semester) was named "Co - mposing (post)|COVID urban sound ECO - logies", occurred in the School of Architecture of Democritus University of Thrace in March 2021 via webcam. At first, a lecture was given with a purpose to highlight contemporary realities and questions about the technology and experience of the urban soundscape, focusing on the necessity of elimination between the dichotomy of digital and physical, especially during the coronavirus disease (COVID-19) pandemic. The theoretical background of the presentation and the methods used (regarding the presentation of the data and the assessment) were based on the concepts of Acoustic Ecology, psychogeography, sound and digital art. The personal sound maps presented in the course focused attention on urban spaces, deemed necessary to transform their typologies due to the COVID-19 pandemic, disconnecting from their materiality, using all kinds of digital data to recruit the necessary new characteristics.

The assessment had a focus on the COVID-19 pandemic that made the experience of non-urban space impossible, the students were asked to draw a map (digital collage), using their memory or technology of a familiar and short audio route or a soundwalk (Sun, 2024, p. 157) with some stops of particular interest. Students had to note in detail the sounds that were heard in these stops either verbally or by using images, sketches, links from websites such as Youtube, Soundcloud, Mixcloud, Free sound, etc. so they would include some sound samples in their

sound map. They had to keep in mind constantly that the soundscape is not defined as an object but rather as a process. And that the concept of soundscape was originally coined to study the relationship between humans and their sonic environment (Grinfeder et al., 2022, p.1).

The purpose of the exercise was to enrich the existing soundscape with sounds (e.g. from animals of your choice) but also sound phenomena (e.g. echoes) that the listener would be able to experience using headphones, by downloading the (theoretical) application to her mobile phone. Deliverable of the assessment was a digital image of a sound map, having links of the proposed digital soundscapes and written statements of the purpose of their existence (e.g. this soundscape exists so as to cover the sound of the street or to create the feeling of the seaside breeze, etc).

Students had two hours to complete the assessment, in their own environment due to COVID - 19 regulations, they presented their projects to other students, via the internet, making comments and communicating their ideas and insights. The goal of the assessment was based on group style teaching creating a positive learning environment, setting clear goals, using and connecting learning to real-life experiences (Ragheb, 2016, p. 1017).

2.1. Examples of student works

Regarding Figure 1, the student group created a Sound Map inspired by the daily routine in the city of Athens, from home to the supermarket and back. The Map 'starts' with the characteristic sound of the coffee machine and the coffee being served. Then you can 'hear' residents leaving the house and the door closing while at the same time you can hear the humming of the cars, the buses, the traffic on the streets and people talking. Towards the end, in the supermarket, the sounds of the products being checked out and the return back home having the front door closed. Students' purpose was to create a complex collage of sounds, which creates a path for everyone within their own imagination.

Concerning Figure 2, students created an audio trail with familiar destinations of the city of Xanthi, associating specific locations with various sounds. The first stop was the Department of Architectural Engineering of Democritus University in Xanthi, having a sound background consisting of a combination of sounds by objects of daily use, like tools used by students in their school e.g. pencils, heifers, scissors, papers, laptops, etc. The second stop was the train station of Xanthi, which urged the students to the nostalgia of the past, choosing to include in their soundmap a melody of the piece "Kemal" by Manos Hatzidakis, which was heard from a lantern. The bridge of the Limnion theme park in Xanthi was the third stop, combined with the sound of the waves of the river, sometimes the river that passes through the bridge is wild and noisy but sometimes is calm and quiet. Arriving at the fourth stop, located in the old town of Xanthi, a melody of the oriental musical instrument Yayli Tanbur was heard. The melody transported the listener to another era while at the same time intensifying the feelings of excitement about the coexistence of different cultures observed in the area. Finally, at the last stop, which is the Path of Life, the sounds of wild animals are heard focusing on the peaceful natural environment of the path.



Figure 1. Students group 4 soundmap of personal Athens



Figure 2. Students group 15 soundmap of Xanthi

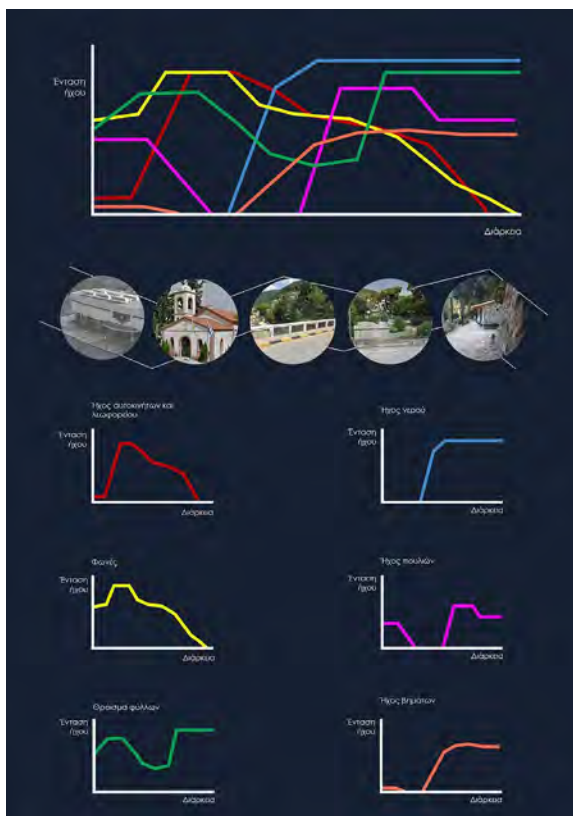


Figure 3. Students group 16 soundmap of Xanthi



Figure 4. Students group 19 soundmap of Mytilene

In Figure 3, the minimalist soundmap was located in the city of Xanthi, having a familiar character, especially for students. The first point of the route was located at the Department of Architectural Engineering, near Kimmeria, from where, as recorded in student's audio clip, the listener experienced a calm soundscape. Later, she was driven by the town bus, to the second point of the route, the Holy Church of Agios Constantine and Helen, located on Vasilissa Sofia, inside the city of Xanthi. The soundscape there was that of a Christian Orthodox church with sounds of Byzantine psalms. As the listener proceeded to the next point of the route, she listened to various sounds, mainly a combination of passing cars humming and birds singing. Thus, when she reached the bridge of the river Kosynthos (Samakov), she listened to the sound of the water that was usually intense. Moving forward, the listener arrived at the ducks, where she met street musicians and listened to the sounds of the small animals of the park. Finally, the route ended at the Path of Life where the sounds that prevailed were natural.

Figure 4 is the sound map of Mytilene that concerned the most central and characteristic area of the city where the images and the sounds were constantly changing. Characteristic was the sound of the ship that arrived every morning at the port. As you cross the waterfront the splash of the waves and the sound of seagulls transported you directly to an island disposal. During the summer months, the traditional and folk music of the taverns raised the spirits and pleasantly attracted the customers. Finally, one of the most important landmarks of the city was the church of Agios Therapondas, with its emblematic architecture and its piercing sound of the bell.

Figure 5 is a soundmap of Berlin in 1989, when The Wall fell. This students' group placed their map in Berlin in 1989, when The Wall had fallen and each area was demarcated and defined. There were no red lines to cross. The intermediate space had joined and became one with the rest of the city. The listener's view was not obstructed and the field of vision was extended and more intimate. On the map, the listener followed the X where something foreign used to stand, and everything seemed more familiar. He listened to the radio, the sounds of people running and smiling. The listener did not understand words but hums, a mob that doesn't remember yesterday because of today.

The student group chose bright colors for the figures of people enjoying the new reality, and did not limit the specific composition only to Berlin but they tried to capture every day as a utopian level where every citizen acted in perfect harmony with her surroundings. The intermediate space became the most important thing and finally the two camps found their common spatial expansion.

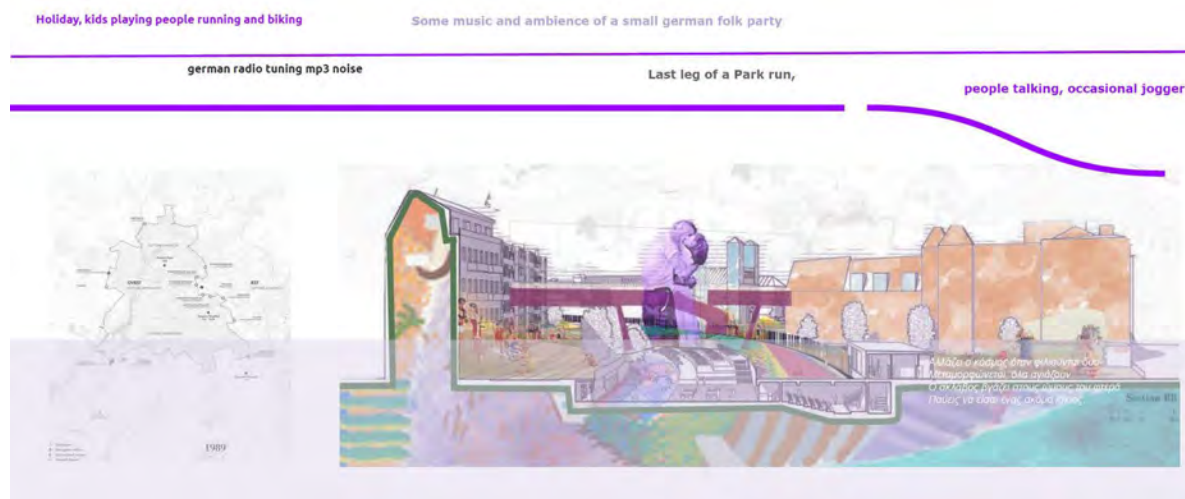


Figure 5. Students group 26 soundmap of Berlin 1989

3. Second academic module

The second academic assessment (part of the course of Architectural Design and New Technologies II, 6th semester) was named "Architecture and sound, design your own graphic score", occurred in the School of Architecture of Democritus University of Thrace in March 2023. At first a lecture was given about the notion of soundscape, keynote sounds, sound signals and soundmarks. A special mention was given to acoustics and sound phenomena, ecology and soundscape ecology and to sound perception. Finally, a series of graphic scores were presented as an alternative way of music representation and notation as well as various audio editing software and sound libraries and databases.

The assessment was based on Murray Schafer's *HearSing*: 75 exercises in listening and creating music, exercise no 22 (Schafer, 2011). Firstly, a description of a walk was given to the students. Afterwards they had to draw a route similar to a graphic score so as to include all the sounds, happenings, etc. The description of the walk that was given to the class was the following:

The musical note walk

I start at home (first point).

I'm going on a straight road.

After a while I turned right.

Later I turned left.

Now the road becomes very bumpy and I have to go back and forth around the stones, a friend of mine is waiting for me.

We climbed the hill together.

The hill is steep and we are soon out of breath.

We sat on top of the hill to talk for a while.

We argue, fight and my friend leaves me.

I go down the slope alone.

At the foot of the hill I come across a river.

I cross an arched bridge.

It's starting to rain. The rain is getting stronger. It sparkles and thunders.

I go running home. Soon the rain stops.

It is already night and millions of stars are shining in the sky.

I am very tired and I am going to sleep.

In a second phase, the students re-read the graphic score and composed a sound sample using real sounds so as to represent each of the events. Deliverable of the assessment was an image and a sound file.

3.1. Examples of student works

Graphic scores can be very artistic and imaginative. They allow you to explore different ideas about art, objects, emotions and environments. Composing with graphics ultimately reflects a desire to see the score not as an embodiment of "the work" but rather as a working document which only comes to live in the social workings of music making (Rebelo, 2015, p 227).

Students did very well concerning the graphic score, they used mainly shapes and visual symbols instead of notes and the more conventional 5-line stave (except figure 11), allowing them to express sound ideas that could not be described by traditional notation. They used, most of the time, a horizontal (from the left to the right) articulation of the sound events (figure 6, 9, 10, 12, 13), but sometimes chose a vertical one (figure 7, 8, 11). They also used color and different fabrics.

Concerning the sound file, the students used mainly sound effects from sound libraries, but in two cases they used musical instruments and more conventional rhythms and melodies. It is rather questionable whether these deliverables are works of art, but they surely raised a lot of interesting issues about the representation of sound, music and space.

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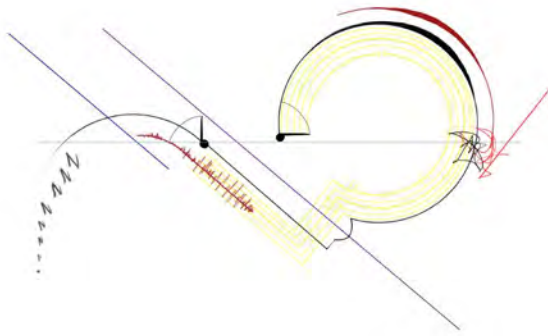


Figure 10. Students group 17 graphic score

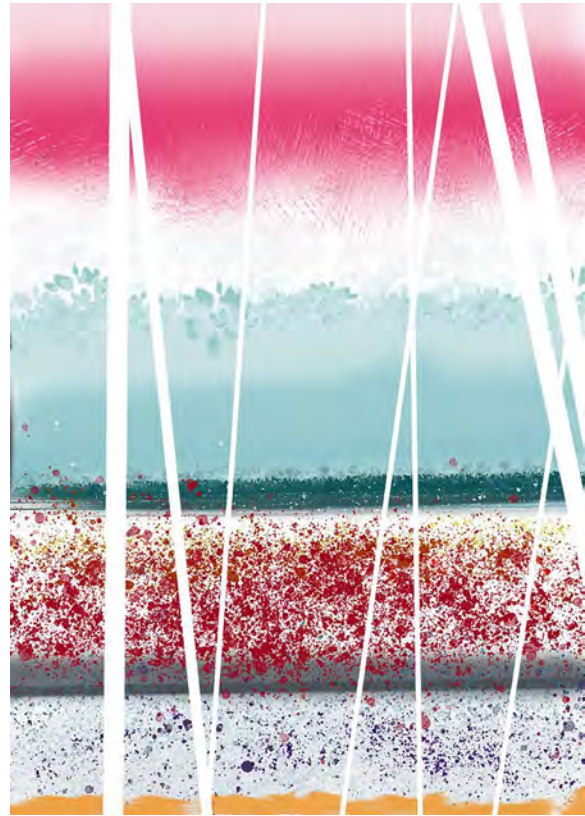


Figure 11. Students group 18 graphic score

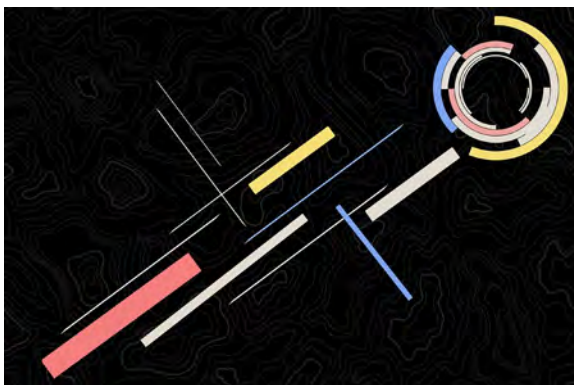


Figure 12. Students group 20 graphic score

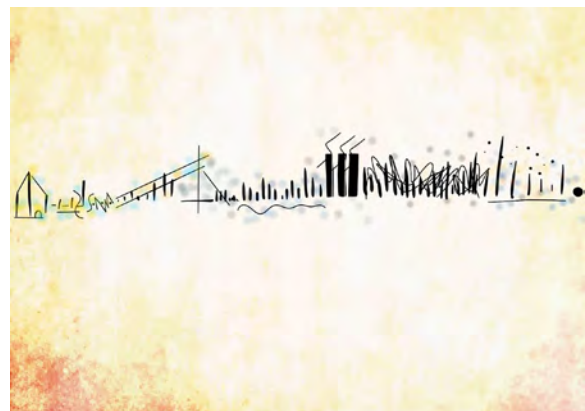


Figure 13. Students group 25 graphic score

4. Discussion

Comparing and contrasting the two short design assessments in the studio, a lot of interesting issues are raised about what constitutes a soundscape, and more precisely, given the fact that the students are future architects, about sound and place.

The first academic module highlighted the creation of a soundmap of the city, and eventually was more realistic and site specific, concerning the soundscapes of a place regarding the identity and cultural meaning. The most interesting fact was that the students used sections to represent their ideas and not plans, as we are used to in previous assessments.

The second academic module about the creation of a graphic score and a sound sample, was more subtractive and artistic. In addition, the audio files and recordings were more easily manipulated by the users. It was

compelling to find out that the use of image representation firstly, and the use of sound afterwards, really worked out for students of architecture.

Students expressed themselves easily and creatively when there was a fixed audio scenario, such as Schafer's description of a walk, in contrast to the module with the sound map, which was more open and vaguer.

Finally, both of the short design assessments tried to represent sound and space as a whole, highlighting the importance of acoustic ecology concerning studies of architecture.

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Program "Soundscapes of Taygetos": From Sound Literacy to Ecological Literacy

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Abstract

This paper presents the main methodological strategies and the results of the project "Soundscapes of Taygetos", that is taking place from 2022 to villages of northwest Taygetos from Taygetos Mountain Academy and Educational Directorate of Peloponnese. Aims of the program are to support mountain research and studies, teacher training, and educational programs for students that come from Greek or other European Schools.

Methodology of the program has been separated to two parts: At the first one, training and education material was developed with research activities at the mountain, and also action research applied to all teaching and training actions. At the second one these materials have been tested in real activities with visiting groups at the mountain.

Beyond these results, however, the research demonstrated the way in which the effects of climate collapse on the mountain reverberate in its soundscapes. Water and its presence in the mountain sounds to be the main echo-generating and sound-making source. And what the evolution of soundscapes indicates is that Taygetos suffers from the effects of the climate collapse, that is "sounds", so that we can shape the "soundscape collapse".

The main theoretical tools on which the formulation of the material was based, i.e., "sound literacy" and "ecological literacy", were complemented by an appropriate 'politics of literacies', which oriented the program towards a contribution to the understanding and prevention of climate.

Keywords

Taygetos, Climate Collapse, Sound Literacy, Ecological Literacy, Soundscape

1. Introduction: From an Educational Program to a better life with sustainability?

For a better understanding of the factors that generated the program "Soundscape of Taygetos", that we are presenting in this work, we will have a reference to the relationship of people and the mountain last decades. After that we will figure out how literacy, as a timeless pedagogical condition helped us to connect sound with mountain's experience in an educational program.

1.1. People and the mountain

Many years ago, and mostly after the 1980's people used to say that Taygetos' villages «are dying». People started leaving their villages to go to the cities, following the general trend of urbanization in Greece (Karakousis, 2008). Nowadays, people more and more say that the «mountain is dying» (Martinis, 2024), when they talk about its inhabited slopes and mountain's abandonment from people. Landslides from heavy rains that sweep away even houses, reduction of spring water available for houses and fields, are the resent effects of climate crisis. At the same time, the recently appeared «canker stain disease», caused by «Ceratocystis platani», which is a threat to the longest living tree-species of the Greek flora, the plane-tree, (MRDF, 2013) cooperates to a great landscape change, and as we will hear, this affects also the soundscape of the mountain. A mountain that changed twice its condition last years after two fire disasters, in 1998 and 2007. Taygetos, although is always

under the possibility of a new fire disaster, according to all evidence, in a country that lost about 10% of its forests during the last twenty-five years (GFW, 2024).

While the mountain is deconstructed below the deconstructed villages, a new trend appears. This trend has to do with people that “return” to the villages, in many ways. Some of them visit the mountain with their families very often and some others turn to permanent residents of the mountain for their own reasons. Younger people are looking for a living with homesteading, natural or natural farming and been active with all the value of life in the air (Martinis, 2023). Older people, sometimes retired, are looking for the peace and wellness of leaving away from industrialized life in the heart of nature.

Main characteristic of the connection of people and the mountain is that it happens with all their senses, including hearing and listening. There are too many characteristic things to hear in Taygetos, such as flowing waters and the sounding creatures of the mountain and all these spread in a “carpet” of silence and human-noise-free environment. So, very soon, the acoustic factor was very important for people that visited Taygetos, as we, of course, know that typically happens when people go to the mountain woods (Sarris, 2024a).

1.2. Education, the mountain and the role of literacy

As soon as Sound Studies and Acoustic Ecology were rising up in Greek educational system (Sarris, 2020a; 2024b), with sound networks, educational materials and proper trained teachers, all over Greece, but also in Messinia, more and more school visits at Taygetos focused on mountain’s soundscape. The local network “Educational Forest of Taygetos” (DPE of Messinia, 2014) has been scheduled sound-focused workshops for students in the mountain Taygetos since 2014. A cooperation of projects including the National Educational Scientific Network “Sound: Environment, Human, Culture” (DPE of Messinia, 2017) and “Taygetos Mountain Academy” (TMA, 2022) gave in 2022 a new program for teacher training and student education called “Soundscapes of Taygetos”, as we can see at the poster of image 1.



Image 1

"Soundscapes of Taygetos" came up after the rising up "sound literacy" (Georgaki, 2015; Sarris, 2020a) and used its practices in order to empower teachers and students' awareness to sound and noise. Sound Literacy could be a difficult to define field, but it's not if we consider "literacy" as a tool for making policy, so that sound literacy expresses our priorities for sound in education. It all starts when "Literacy" as a theoretical field appeared in the 1990s' as a new methodology named "new literacy studies" (NLG, 1996). This new field helped teachers to understand new multimedia texts and technologies and by this to schedule more efficient and focused lessons in the classroom. Since then, literacy is understood as something "more" than writing and reading the language. Nowadays literacy is about "writing and reading" codes and meanings in complex, literated cultural and semantical environments and that's why we put "writing and reading" into quotation marks.

If students, and citizens in general, acquire sound literacy skills, acquire access to a more holistic and efficient way to understand the world they live in, the environment, themselves and the relationships between these two last parts.

But maybe we have to ask: who develops sound literacy? And then the answer maybe is another answer: Who develops any kind of literacy? Now we have to answer with an affirmation and denote that always someone develops, plans, schedules every mentioned literacy. In other words, what's important is to realize that literacy is something to be planned, and that makes it a policy tool. Every literacy is a potential strategy tool for the trainer and a facility for the trainee for "surviving and managing" in the related literated environment. With literacy, literated environments can be separated each other, entrenched, but also meet each other. In our case, as soon as we decide to connect sound literacy with environmental knowledge, climate crisis and the environmental future of our lives, we are in the root of an ecological literacy policy also.

Developing sound literacy in the mountains, according to the values of "paideia" and education seems to be a one-way root to get to ecological literacy. Even if someone wants to develop sound literacy for aesthetic purposes or just to increase the environmental knowledge, the facts, the rapid changes that happen in the mountain during last years because of the climate collapse, will drive him to conclude the necessity of ecological literacy.

This, for education maybe is another chance to help students acquire a special type of ecological literacy, related to "climate change literacy" (Johansen, 2017; Peterman, et al., 2017a, 2017b; Azeiteiro, et al., 2018). Of course, as things are not getting well, maybe "climate crisis literacy", (Baral et. al. 2024), "climate collapse" (Orr, 2009) literacy, or as Secretary of United Nations António Guterres (2024) recently suggested "climate chaos" literacy maybe are terms that approach the reality more reliable.

2. Soundscapes of Taygetos: Theoretical and Methodological Base

"Soundscapes of Taygetos" has been designed for students into activities (a) "before", (b) "during" and (c) "after" the visit at the mountain:

a) Before visiting the mountain program tutors help teachers to introduce students to soundscape studies for students. Students learn key concepts, methods, tools and theories such as "soundscape" (Etmektsoglou, 2014), "sound metering" and "spectrogram" (Sarris, 2018), "sensewalking" and "soundwalking" (Sarris, 2024a), "colors of noises", "acoustic footprint" (Sarris, 2018) etc. If it is necessary teachers get self-training or participate in training courses included to the program. According to school priorities teachers use holistic methods of sound education and "echopedagogics" (Sarris, 2017, 2020b, 2024b) and potentially they include the visit to the mountain to an official sound-related project supervised by the Ministry of Education (School Activities Program) (Sarris, 2024b). The studying group learns how to use school tablets and (if they are suitable) mobile phones, all with the proper applications (selections from sound meters, audio analyzers, tone generators, soundscape players, spl video cameras, screen capturing applications, and sometimes sound recorders) (Sarris, 2023). Altogether, students participate in an online chatting and file-sharing room to the social media platform that the school suggests. In the classroom the group shares some key information about the mountain, its environment and culture and the general didactic purposes of the visit to the mountain.

b) During visiting the mountain, the group follows a prescheduled route adapted to the age, the walking abilities and the main theme of the visit or the related project that students work on at school. The route includes paths near or in nature, deep in the forest, path in the villages and walking on the car roads of the mountain between fields, houses or local old and historic buildings of the mountain. The process of researching to the field of mountain Taygetos includes stops in interesting points that students hear and capture on the screen of the

spectrograph seconds of the soundscape. Then they upload their screen shots at the chat and sometimes a photo of the captured landscape or some text with notes about the place. There are many variations to this activity based on the visualized result in the screen. Students have in mind to make clear at the capture the elements of the soundscape that they want to analyze later in the classroom.

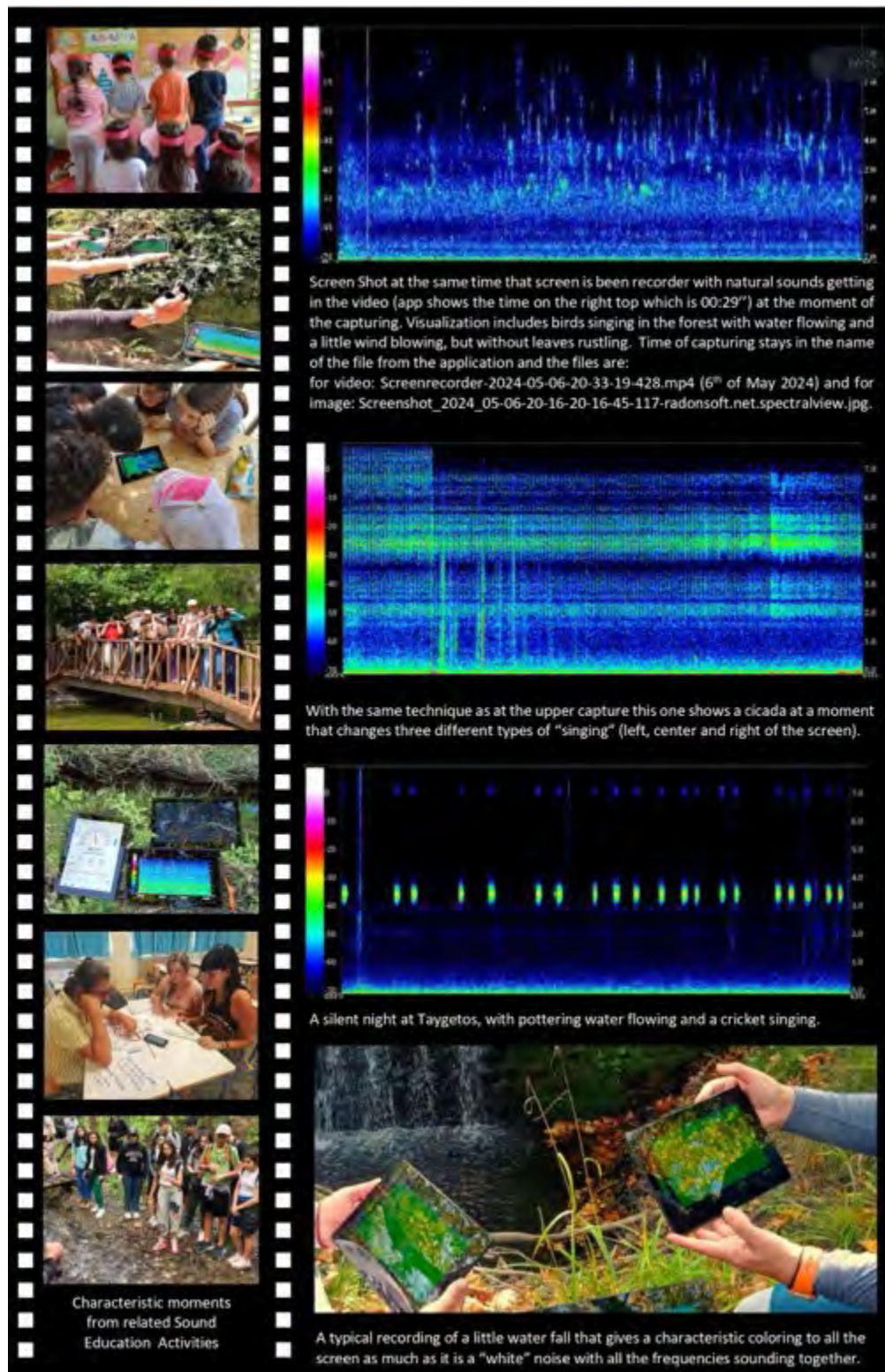


Figure 1

c) After visiting the mountain, a brief presentation of the findings helps to sum up and make conclusions. Experience shows that student love to make soundscapes capturing even at home, at their play, any time of the day and focus on the visual elements that appear on the screen. We must consider this as the beginning of a sound literacy. Finally, we must consider that every school group that visits Taygetos during the program “Soundscapes of Taygetos” includes this experience to its different and unique project. Some thematic that we met are related to subjects such as “Homesteading and Sustainable Living”, “Living in the Mountain”, “The cycle of the water”, “Geo-Mythology”, “Healthy living and Nutrition” and other.

3. Findings and discussion about climate effects at “Soundscapes of Taygetos” Program

Although “Soundscapes of Taygetos” initially had a timeline for only a few months a great response from schools all over Europe made the organizers turn it to a longer project, with visits at the mountain all the months of the year. We have findings from 2022 to today, with observations from all the seasons. Comparing the captions and the data from these years we can hear very clearly the consequences of climate change. It seems that environmental change in Taygetos can be understood also with its sound footprint.

Changes in the water presence, in the shape of the land, at the flora and consequential changes at the soundscape. As far as these indicate the climate collapse, we named this soundscape change to a “soundscape collapse”.

Landscape and Soundscape changes at Northwest Taygetos during 2022-2024			
#	Environmental change	Changes affecting soundscape	Soundscape change
1.	Less rain causes less flora	Soil surface without foliage	More echo and open space
2.	Less flora gives less fauna	No insects and animals	Flat and silent soundscape
3.	Less rain causes flowing water reduction	Reduction of amount, surface and speed of sounding water	Lower water sounds and decrease of colored noises
4.	Less flowing water reduces riparian vegetation	Quick and more silent flow of the torrents	Less “notes” at the water gurgle
5.	Dead trees from diseases or/and dry soil	Logs on the ground, open area	More echo and open space sounding in the air, changes at the water flowing paths
6.	Dead trees don’t host birds	Absence of Flying creatures and birds that live on trees	Silence without birds singing.
7.	Less water flowing in general - sometime stops in the summer	Lowering of the riverbed or disappearing of torrents and rivers	Flowing water sounds with lower volume, higher pitches, or stops sounding

Table 1

So, soundscape collapse is most of all a collapse of water resources on a constant basis, without counting rains and storms. It’s a collapse of the relationship between water of the earth and soil. As table 1 indicates, less water changes the flora and fauna, and the spaces around that sound travels, change also. The sounding results start from the sounding water, the sounding foliage, the creatures (fauna) and finish at the shape of the earth, the open spaces with unusual less flora, and the new forest geometries that boost echo, a sense of “dryness” and loneliness at the soundscape’s feeling, sometimes a silence exists, that doesn’t sound normal for a forest and gets to the limit of scaring silent soundscape.

“Soundscapes of Taygetos” recorded this soundscape collapse into two scales: The one records the difference between winter and summer. The old stability to the soundscape all the year has gone as far as in many cases water stops flowing in the summers and parts of the mountain gets dry and dehydrated. The second one records this change year by year. Winter sounds different from the summer, but also, winter of today sounds different than four years ago, and the summer of today also has been changed dramatically, since the disappearing of the water and the stopped springs is something new for nowadays.

Students that visit the mountain usually don’t have the opportunity to go to the field twice, for example in the summer and in the winter. They come to the field once and there they learn about the environmental changes

that the climate collapse brought. What they get is the method and the curiosity to observe and find out how climate collapse affects their places, the lands they live in or visit.

4. Conclusions: Climate Crisis Literacy and Sound Education

Kalamata, the municipality that includes six communities-villages of northwest Taygetos (Alagonia, Artemisia, Karveli, Lada, Nedousa, Piges) is one of the recently flooded areas of the country (Kalamata Journal, 2024a). Also is one of the one hundred selected after competition cities in Europe (Kalamata Journal, 2024b) with the mission to develop Climate neutrality (EC, 2022; NZC, 2024). So, there are much to live and to do about climate collapse in Taygetos, which is our subject. That means that there are many things to live and do about the soundscape collapse, which is the heard side of the same problem. Focusing on a better, sustainable and climate neutral future for our children the course has very clear steps. Starts from the problem in the climate and ends at the proper education for climate crisis (or collapse, or chaos).

Soundscape studies in Education seems to be the tool and method in the beginning of the course and the proper literacy policies seems to be the tool at the end of it. But the main aim is always one: To respond to this alert about the worst future that is coming.

"Soundscape of Taygetos" indicated the connection of Sound Literacy with an Ecological Literacy focused on the Climate Crisis Literacy issues. Sound is an instant experience of the environment and increases our awareness to environmental and climate crisis issues. Sound in education is something that students love and new technologies bring this beloved thing more attractive to the learning experience. That means that we have a lot to do on sound in education, on sound studies in education, on soundscape studies in education.

Pedagogically and didactically, there are too many extensions to what this program can offer to the school education. It can be connected to all the teaching subjects and can help to any content literacy. That is another option of this that we don't discuss here. Actually, it has to do with the so called efficient experiential learning. So, people that consider to include methods and findings from "Soundscapes of Taygetos" to their educational plans should have in mind these two parallel positive characteristics of it: It is a program that refers straight to the sustainability problem of all of us, at the same time that it can help and enforce the teachers' effort from all sides.

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Aural Inclusion: Bridging Sound Art and Technology for/with the d/Deaf and Hard-of-Hearing

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Abstract

The paper discusses Audibility, a cross-disciplinary project that explored the intersection of sound art and Deaf and Hard-of-Hearing experiences within the framework of B-AIR: Art Infinity Radio (2021–2023). Challenging the “naturalized exclusion” of d/Deaf individuals from sonic culture, Audibility sought to expand participatory sound practices and propose auditory and sonic engagement beyond cochlear-centric paradigms. Drawing from workshops in a School for the Deaf and Hard-of-Hearing and the Greek National Opera in Athens, the project developed inclusive methodologies for sound education and creation—emphasizing visual, tactile, and imaginative engagements with sound. Central to the initiative was the notion of the soundscape as a commons, shifting focus from individual adaptation to collective accessibility. The paper refers to participatory artistic education curricula, including technological applications on sensory translation (spectrograms, waveforms, graphical scoring), choreographic experiments, vibrotactile tools, and broadcasting. Through these practices, Audibility foregrounds aural diversity as both a sensory and cultural phenomenon and calls for deeper integration of Deaf and Disability Studies within sound art and acoustic ecology. The outcomes contribute to a broader reconceptualization of listening and sonic engagement as pluralistic and contextually situated modalities of perception.

Keywords

Sound art, Deaf experience, artistic research, workshops, project overview

1. Introduction

*Audibility*⁵⁵ was a project concerned with aspects of aural perception and sonic creativity among the Deaf and hard-of-hearing. The project was part of “B-AIR: Art Infinity Radio - sound art and music for babies, toddlers and vulnerable groups” Creative Europe program⁵⁶, that lasted between the years 2021-2023, and explored the intersection of sound art, radio art and music, with the intention to widen the basis of participation in sonic production and attendance, by addressing particular audience groups (such as babies and toddlers, retirement homes residents, war survivors, or neuro-atypical audiences). And at the same time to systematically integrate scientific research into artistic creation processes, using publications and documentation as a tool to further distribute knowledge and expertise⁵⁷.

In this paper, we will provide a detailed overview of the project, exploring key aspects of participatory artistic creation, the experiences of d/Deaf individuals, and the potential for integrating d/Deaf and Hard-of-Hearing communities into sound art and acoustic ecology’s field. We will also reference previous studies on the subject.

⁵⁵ More on <https://b-air.infinity.radio/en/research/audibility-deafsoundart/> accessed on 4/11/2024.

⁵⁶ B-AIR’s official site, <https://b-air.infinity.radio/en/> accessed on 30/10/2024.

⁵⁷ For more information on the project all interventions and results are published under a common textbook available at <https://b-air.infinity.radio/en/e-book/> accessen on 17/11/2024.

However, as this is an emerging field, few projects have addressed these specific communities due to the historically “naturalized exclusion” of d/Deaf and Hard-of-Hearing individuals from sound and sound art. Additionally, we will present a comprehensive account of the program’s workshops, mentioning their technical components and methodologies. Drawing from the team’s research and practices, we will reflect on the project through a lens that bridges theory and practice. These reflections are not intended to establish definitive guidelines for merging sound art and acoustic ecology with d/Deaf experiences. Instead, they aim to contribute to a more inclusive expansion of the field while inviting us to engage in dialogues across disciplines, including Disability and Deaf Studies, Sound Art, Sound Studies, and artistic education.

In the framework of the project, both authors worked closely in TWIXTlab⁵⁸, a non-profit organization devoted in the conjunction of contemporary art, anthropology and everyday life. We initially approached Schools for the Deaf and Hard-of-Hearing in Athens, as well as artists working on relative themes, like their own experience with sound as Deaf individuals, or working with diverse media that highlight alternative modalities of sonic perception, like vision and tactility. By doing so, we aimed at creating learning experiences for all parties involved in the process: students, teachers, artists, and ourselves as participant observers. We are particularly grateful for the enormous help of anthropologist Panayotis Panopoulos (Aegean University), who invited us in the endeavour in the first place, and who had already been working on the themes of Deaf art and cultural expression, particularly focusing on critical and ontological perspectives of Deaf voice⁵⁹; as well as visual artist and curator Ourania Anastasiadou (Accessibility dept. of the ASFA), a key figure in the Deaf community and art in Greece.

2. How does the world sound if we cannot hear it?

One might find that these approaches have little to do with the scopes of acoustic ecology; they might think that the Deaf are not able to appreciate the richness of the soundscape, to enjoy music in its fullness, to distinguish the sonic timbres that surround us. We understand these arguments as an aftereffect, or an outcome, of what we call “naturalized exclusion”, in this case, the tendency to reduce sonic perception into the function of the cochlear, to measurable medical data, and perhaps to the capacity / effectiveness -at the end of the day, the price- of hearing aids or cochlear implants. And subsequently, to consider the approach of Acoustic Ecology with Deaf studies as futile.

This, however, is only one way for understanding Deaf experience. It heavily relies on the so-called “medical model” for disability, which considers deafness as an “impairment” to be “cured” or “corrected”. We do not overlook this approach both as a field for individual dwelling strategies/tactics, as much as a fertile ground for ground-breaking technological innovation. There exists a wide range of interpretive frameworks and models for understanding disability, and thus the deaf experience. These include the medical model, the social model, the humanistic perspective, the religious and/or charity approach, and others. Each of these distinct approaches plays a vital role in shaping our understanding of disability and informs the development of policies related to it (Friedner & Kusters 2020: 31-47).

On the other hand, we wish to reverse the argument. Through the strategic conceptualization of “the soundscape as commons”, we wish to shift the attention from individual responsibility to societal action. The “social model” for disability informs the idea, that it is not the individual that needs to adapt to the majority’s expectations, but society needs to change, in order to accommodate and enrich itself with diverse experiences.

By pointing out that the initiation to the world of acoustic ecology requires the tuning of the ear⁶⁰ through education and training, we call attention to the sharpening of the educator’s sensibilities to the diverse ways of the Deaf with sound. This might require putting more emphasis to multi-sensory sonic perception, to sound visualization technologies, to the importance of light and visibility, proximity and tactility, to the relativization of

⁵⁸ More information on TWIXTlab’s official site, <https://twixtlab.com/2022/09/25/tangibleradioresidency/> accessed on 12/09/2024.

⁵⁹ Panopoulos, P. 2021. «Deaf Voices / Deaf Art. Vocality Through and Beyond Sound and Sign», *Journal of Interdisciplinary Voice Studies*, 6(1): 9-26

⁶⁰ Schafer, R. Murray. 1977. *The Soundscape – Our Sonic Environment and the Tuning of the World*. Vermont: Destiny Books, and Southworth, Michael. 1967. *The Sonic Environment of Cities, Environment and Behavior*. Massachusetts Institute of Technology: Massachusetts.

amplitude and sound volume, and to the understanding of hearing as a social experience. As Deaf artist Christine Sun Kim⁶¹ puts it, to "perceive sound by looking to (hearing) others".

3. Sounds unheard

Audibility explored the intersection of sound art and the deaf experience. As part of *B-Air: Art Infinity Radio*, it was coordinated by RTV Slovenija. Partners include institutions from Serbia, France, Slovenia, Croatia, Bosnia and Herzegovina, Greece, and Finland. Through creative encounters between sound artists, students, and teachers in Special Schools for the Deaf and Hard-of-Hearing, *Audibility* promoted art-sound education in various contexts⁶². We organised and facilitated workshops to foster collaborative creation and explore alternative ways of experiencing sound beyond hearing. The project also aimed to develop an inclusive curriculum and methodology for sound and music education that can benefit Deaf and Hard-of-Hearing students and broader audiences.

We developed a pilot curriculum for Deaf and hard-of-hearing adolescents, which held hands-on experimentation at its epicentre, inviting artists to work with the students and teachers, and thematize sonic perception in various modalities, and participation in the sonic praxis. Through presentations and hands-on workshops, *Audibility* introduced participants to sound as an artistic medium, creating space for Deaf and Hard-of-Hearing students to perceive and engage with sound in diverse ways. Artists, students, and teachers worked together to create original art pieces, as well as to explore listening devices, using sound as a general category of perception not limited to the cochlear.

A central goal of the project was to broaden our understanding of sonic perception beyond hearing. This effort involved designing a curriculum specifically tailored to enhance aural education for Deaf and Hard-of-Hearing students. The curriculum aimed to serve as a model adaptable to a wider range of educational contexts, bringing alternative ways of experiencing sound that could include the Deaf and Hard-of-Hearing.

In the first workshop series, Deaf artist Tatiana Remoundou collaborated with children to create compositions based on frequencies personalized to each child's audiogram, exploring the diversity of individual hearing experiences. The second workshop, led by Lambros Pigounis, involved an exploration of resonance in visual and haptic terms, where pupils observed patterns formed on vibrating surfaces using materials like salt and sugar (the well-known Chladni Plate), alongside a DIY sound and laser projection system. In the third workshop series with Kalliopi Takaki, Petros Flambouris, and Giorgos Mizithras, a vibrating radio prototype was developed, enabling students from the Special School for the Deaf and Hard-of-Hearing to create their own radio show, featuring their own distinct Deaf voices and sounds they specifically picked for a common audio composition.

Further expanding on these explorations, a year-long seminar was held at the National Opera in Stavros Niarchos Foundation, that brought together practitioners to discuss Deaf art and the embodied experience of Sound Art. Led by Dana Papachristou, Yorgos Samantas, and Orestis Karamanlis, the seminar introduced visual coordination and vibrotactile composition techniques through piano, percussion, graphical scoring, and software, leading in an improvisational piece involving Deaf participants and the Transcultural Orchestra under the conduction of Harris Lambrakis.

Earlier that year, two additional artists, Canadians Leslie Putnam⁶³ and David Bobier⁶⁴, conducted a residency in Athens, where they offered a masterclass and a collaborative workshop. Their work in *Audibility* brought together practitioners and fostered a collective spirit of creativity and shared knowledge. Their input was valuable as they have been working with the Deaf and Hard-of-Hearing for a long time and in different contexts, such as exhibition *Other Abilities*⁶⁵ curated by Eva Fotiadi and Adi Hollander.

⁶¹ Sun Kim, Chr. 2015. «The Enchanting Music of Sign Language» (TEDx Talk). Available online https://www.ted.com/talks/christine_sun_kim_the_enchanting_music_of_sign_language/transcript?language=en (accessed on 17/10/2021).

⁶² More information, curatorial texts and audiovisual documentation can be found on the project's website: <https://b-air.infinity.radio/en/research/audibility-deafsoundart/>; <https://b-air.infinity.radio/en/sound-art-plus/tangible-radio-class-on-air/>; and <https://b-air.infinity.radio/en/learning/audibility-inclusivityandsoundart/deaf-sound-art-hearing-as-a-bodily-experience/> (accessed 08/06/2024).

⁶³ <http://www.leslieputnam.com/> (last accessed on 5/8/2024).

⁶⁴ <https://bodiesintranslation.ca/david-bobier/> (last accessed on 1/10/2024).

⁶⁵ More on *Other Abilities* artists and artworks on <https://otherabilities.org/> (last accessed on 28/05/2024).

Audibility aimed to deepen understanding and appreciation of the relation between Deaf and Hard-of-Hearing individuals and sound. The project's educational framework provided various new tools and approaches for sound engagement, aiming –among others- at the adoption of its results in Special School curricula and promoting co-learning among Deaf, Hard-of-Hearing, and hearing communities. Building on the methodologies outlined earlier, we explored ways to extend sound beyond cochlear perception by integrating sound visualization, image sonification, experimental sound practices, DIY tools, radio production, and innovative design approaches. We chose to work within the school environment due to the collaborative efforts between our team and the teachers, the young age of the participants, and the secure, supportive setting the school provides. Sign language interpretation was always present, as it is the primary language used and taught in Special Schools for the Deaf and Hard-of-Hearing.

4. Reflections

Reflecting on *Audibility* project, our experience with the initial workshop brought surprising insights into the concept of aural diversity within the Deaf community and beyond. Tatiana Remoundou, the Deaf artist leading the session of the first workshop, had planned to use personalized audiograms for each student, hoping to create sound compositions tailored to their unique hearing ranges. Although this plan evolved as we faced practical and ethical challenges, the alternative approach – a common sound and movement playful workshop- allowed us to creatively experiment with sound in ways that still honoured each participant's auditory experience. As we adapted, we became aware of the diverse ways in which each individual hears. This given diversity shifted our perspective, revealing that "deafness" is far from a singular, silent experience.

Through this process, we encountered students across a spectrum of hearing experiences: those profoundly Deaf, those with varied frequency ranges, those using cochlear implants or hearing aids, and others identifying as hard-of-hearing. Moreover, pertaining to the Deaf community, with capital D we also encounter C.O.D.A. individuals, meaning the Children of Deaf Adults, using sign language as their mother tongue. From this, we learned to perceive deafness as a cultural identity relevant to the deaf culture⁶⁶, rather than an impairment. Through the project, each participant's interaction with sound offered a unique insight into the aural diversity⁶⁷ that exists within the Deaf community. What emerged was an understanding that "deafness" is not a mere descriptor for absence of sound but rather an identity that encompasses a wide range of listening and perception modes⁶⁸.

This realization enriched our approach to listening within the project and beyond. It underscored that, for some, Deafness represents a cultural and sensory identity⁶⁹ with its own perceptions of sound, rhythm, and vibration. Embracing this diversity, we found ourselves working more inclusively, acknowledging the range of hearing experiences into our program. The workshops ultimately served not only as an introduction to sound art but also as a manifestation of the many ways in which sound can be experienced and perceived across the Deaf and Hard-of-Hearing communities.

Moreover, *Tangible Radio*⁷⁰ emerged as a central piece of the *Audibility* project. This was a device conceived by Yorgos Samantas and designed by Petros Flambouris, built to transmit a radio show collaboratively crafted by the students, with the facilitation of Kalliopi Takaki and Giorgos Mizithras. This radio device was more than just a medium for sound transmission; it became a platform for Deaf and Hard-of-Hearing students to share, amplify and reproduce their auditory perception in the form of vibration, enabling dialogues around sound, voice, and storytelling.

One striking aspect of the project was the choice of sounds the students chose to broadcast. Many of these sounds—like the sound of the moon, or of city lights, can only be imagined. These sounds, imagined and vocalized by the students as part of an auditory landscape "in a planet where only the Deaf could listen" (as was the workshop's cue towards the students), felt like a kind of coded language, a "soundscape" exclusive to the Deaf,

⁶⁶ Harvey, E.R. 2008. «Deafness. A Disability or a Difference». *Health Law & Policy*, 2(1): 42-57. Available online: <https://digitalcommons.wcl.american.edu/hlp/vol2/iss1/6/> (accessed on 12/04/2023).

⁶⁷ Drever, J. L. & Hugill, A. (eds). 2023. *Aural Diversity*. London, New York: Routledge.

⁶⁸ Drever, J.L. 2019. « "Primacy of the Ear" – But Whose Ear? The Case for Aural diversity in Sonic Arts Practice and Discourse». *Organised Sound*. 24(1): 85-95.

⁶⁹ Friedner, M. & Kusters, A. 2020. «Deaf Anthropology», *Annual Review of Anthropology*. 49: 31-47.

⁷⁰ Papachristou, D. 2024. *Tangible Radio: Deaf studies and sound studies coalitions*. *Organised Sound* 29(1):1-11.

describing a world the pupils alone could access. Their selections revealed that their approach to sound was rooted not in the hearing majority's auditory realm but in the premises of imagination and creation.

A second powerful theme was the inclusion of their Deaf voices⁷¹ in our collaborative radio broadcasts. Beyond the use of locally established sign languages, the Deaf voice represents a unique acoustic and linguistic space. It refers to the vocal expression of individuals who do not rely on hearing to regulate their speech⁷². Deaf voices are distinct, unique to each person, and can be refined through speech therapy. Symbolically, the voice carries significant weight as a metaphor for social visibility and advocacy⁷³. Politically, it plays a crucial role in promoting the inclusion and representation of d/Deaf and Hard-of-Hearing individuals in public life⁷⁴. As a shared acoustic element, the Deaf voice bridges the Deaf community and the broader society, enriching the diversity of oral/aural communication.

In mainstream media, the Deaf voice is almost entirely absent—rarely represented and even less often recognized on its own terms. Sign language is only visible in news broadcast on television, leading to the false assumption that d/Deaf people do not speak, don't have a voice. This is of course very far from the truth. The outdated and offensive word *kofálos*, [deaf mute], highlights how the Deaf community is seen and characterized by the listening majority, in the sense of a "listening gaze" or "ableist stare"⁷⁵.

By broadcasting the students' stories and voices on a radio conventionally tied to the hearing world, we attempted to create some space for a widely marginalized form of expression to be heard, touched and felt. The broadcasts, which travelled to venues like the Venice Architecture Biennale and Cerisy-La-Salle in France, went beyond mere documentation of the project; they invited audiences to experience the Deaf voice on its own terms, expanding definitions of both radio and voice to encompass this underrepresented perspective.

Through *Tangible Radio*, the students' Deaf voices found a way-out, expressing not only their identities but also their interpretations of a world filled with unheard "sounds." It became clear that the project was not simply about teaching Deaf students to interact with sound but about redefining the boundaries of sound art to honour their voices and narratives, challenging listeners to reconsider what sound, voice, and even silence can mean.

5. Conclusion

Audibility challenged us as well to rethink the concept of listening, revealing it as a diverse and deeply personalized experience. There are so many ways to listen—by mimicking the listening patterns of others, through social listening, or by tuning in haptically and/or visually to vibrations and rhythms. For some, listening is visual, interpreting sounds through sight or even as feelings. In Greek, "listening" has layers of meaning: it can imply obedience, attentiveness, or even the delicate balance of flavours in a dish. These nuances speak to how listening can serve as both an act of receptivity and interpretation.

At an acoustic ecology conference, where discussions often focus on what is the "valuable" soundscape—the sacred, the natural, the pure—, and how we can capture it in high definition, we wish to introduce a new dimension: listening through the experience of hearing diversities. Deaf and Hard-of-Hearing perspectives can broaden our understanding of what a soundscape can be, of what sound in general is, reminding us that sound doesn't always align with audibility through the cochlear, through the ear. Listening with hearing diversities doesn't lessen the sensory richness of a soundscape; it redefines it.

By including these perspectives, we're not only attempting to widen the scope of acoustic ecology but also challenging conventional ideals around sound and sonic awareness. Just as listening has countless forms, so does our understanding of the soundscape in which we are immersed, one that acknowledges and values the diversity

⁷¹ Panopoulos, P. 2021. «Deaf Voices / Deaf Art. Vocality Through and Beyond Sound and Sign», *Journal of Interdisciplinary Voice Studies*, 6(1): 9-26.

⁷² Wirz, Sh. 1991. «The Voice of the Deaf», in Margaret Fawcus (ed.). *Voice Disorders and their Management*. Boston: Springer. pp. 283-303.

⁷³ Johnson, J. & Kennedy, K. 2020. «Introduction. Disability, In/Visibility, and Risk». *Rhetoric Society Quarterly*. 50(3): 161-165. Available online <https://www.tandfonline.com/doi/full/10.1080/02773945.2020.1752126> (accessed on 20/03/2023).

⁷⁴ Lawy, J. R. 2017. «Theorizing Voice. Performativity, Politics and Listening». *Anthropological Theory*. 17(2): 192-215. Available online: <https://journals.sagepub.com/doi/full/10.1177/1463499617713138> (accessed on 10/02/2023).

⁷⁵ Schmid S.J. 2024. The Ableist stare: an interdisciplinary, narrative-driven exploration of staring at disabled bodies. *Medical Humanities* (50):466-474.

of hearing experiences within it. Through *Audibility*, we have been working in exactly this: to establish a more inclusive sound culture—one that invites Deaf and Hard-of-Hearing voices to shape how we perceive, understand, and appreciate our acoustic environment.

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Acoustic Oiko-topia: Educational aspects of collectivity and sustainability through sound

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Abstract

The soundscape has the capacity to connect living and non-living entities through sound, adding a dimension to Acoustic Ecology that is connected to the collective consciousness by means of sonic materiality. This research presents educational activities of environmental sound art and sound studies related to the formation of this sonic collectivity. How it is crucial for developing sustainability and for promoting acoustic justice - which is associated with the political connotation of listening. Acoustic Oiko-topia is a workshop for primary school children that took place at the Museum of the Environment, Greece. The aim of the project was the presentation of nature as a common space of dwelling through sound. It focused on the following categories: a) The importance of vocal communication -through experiential exercises. b) The role of the acoustic communication of biofauna- through specific examples c) How humans interfere with biophony resulting in its extinction and in changing the acoustic character of the seasons d) How field recording practices enable students to understand in situ the role of human interference and to cultivate acoustic co-presence.

Acoustic Oiko-topia educational programme is a sonic exploration of connections and interferences that fosters community engagement and cultivates a collective acoustic consciousness. The proposed methodology results in an understanding of how human noise affects seasonal and climatic conditions and how humans can take action to promote sustainability through active listening.

Keywords

Acoustic justice, environmental sound art, biophony, sustainability education

1. Introduction

The contemporary theories of sound studies are founded upon the non-anthropocentric conceptualization and production of sound space (Labelle, 2012, Thompson, 2017, Vrakatseli, 2019). If we focus, for example, on the soundscape of a forest, we notice that it forms a network of sounds, including the rustling of leaves and the voices of birds and other animals. The goal of this research is the understanding of sustainability in sound art education through listening engagement. This research promotes *acoustic justice* through active listening, ecological consciousness and sonic engagement. The term *acoustic justice*, as coined by sound theorist and artist Brandon Labelle (2020), draws attention to the political connotation of listening. In the contemporary era, listening has become an active component of the citizens' participation and engagement in the political process. Labelle situates the concept of acoustic justice within a "critical ecological framework", wherein the ability to both hear and to be heard is identified as a defining characteristic of the contemporary active citizen. Emphasis is placed on who and what is going to be heard. This process results in the formation of a shared acoustic collectivity. Although the aforementioned analysis of acoustic justice places greater emphasis on social equality, it also highlights engagement through listening beyond human societies. Listening to the ecosystems can assist in sustainable development practices, thereby fostering a sense of belonging. Furthermore, the contemporary movement of ecological sound art emphasises on an "ecological mode of listening," which underscores the concept of coexistence within a dynamic ecosystem (Gilmurray, 2020). Although there are projects that engage the community (such as Biosphere Soundscapes) this approach is mainly achieved through the use of "artistic

metaphors" (Gilmurray, 2017). *Acoustic Oiko-topia* presents a framework for educational workshops to foster community engagement through the development and enhancement of ecological sound art methodologies.

2. Animal behaviour and climatic conditions

Weather affects the way all life makes sounds. Weather is the way the world is audibly blown by the winds and brushed by its waters.

We hear, feel and think to understand the sonic information necessary for survival for life

Charlie Morrow, sound artist, 2021

The behaviour of animals and birds has been used as an indicator of climatic conditions, seasonal phases and as a means of predicting the weather. For example, the pulses of the snowy tree cricket (*Oecantus fultoni*) can be used to determine temperature in Fahrenheit (by adding forty to the fifteen second pulse) (Krause, 2002). In ancient times, Theophrastus in his book *Weather Signs* observed that "If sparrows in winter begin to be clamorous at evening, it is a sign of a coming change or of a fall of rain" or "It is a sign of storm when the crow or raven or jackdaw makes its call late" (1926, par. 28 and 39). Following the above, biophony in ancient times was an indicator of climatic condition. Another example of animal behaviour, addressed by Plutarch (n.d. par.2) in his work *Natural Questions* is associated with the appearance of the cuttlefish on the surface of the water acting as an indicator of a storm. Furthermore, bees have the ability to predict the occurrence of frost or rainfall by not flying great distances, as documented by Claudius Aelianus (1958, par.1.11).

A similar phenomenon has also been observed nowadays, by agricultural communities in Western Greece-in the canal of Lefkada island, in the context of writers' sensory/sound studies research (unpublished). Three farmers involved in the research project have noted a change in weather signs. A Vlach woman born in 1938 and raised in a pre-industrial society in the Acarnanian mountains noticed that "the nature has changed... (weather signs) are confused because climate has change". By mimicking the birdsong, this woman was able to speak with the birds. The natural dynamics of ecosystems and the survival and reproduction of animals are affected by both human activities and climate change, according to the theory of Bioacoustics. For example, the calling activity of birds and insects has undergone a transformation as a consequence of the elevated temperatures that characterize climate change (Scarpelli, et. al., 2023). *Acoustic Oiko-topia* will facilitate an understanding of the role of human noise in seasonal and climatic conditions and of the sonic ways in which humans can enhance environmental sustainability.

3. Research design of Acoustic Oiko-topia workshop

The Acoustic Oiko-topia workshop, held at the Museum of the Environment at Lake Stymfalia in Greece in 2024 on the occasion of the International Museum Day, presented an innovative approach to sound art education. The programme has been developed for use with primary school children. The term Oiko-topia is a paraphrase in Greek of the word "soundscape". The Greek word "Oikos", that means home, denotes a place where one cultivates a sense of belonging. In this context, the soundscape is presented as an environment of connection and habitation. The objective of this workshop is to demonstrate to students how human-generated noise interferes with the dynamic network of environmental sounds, including animals' voices, resulting in changes in both the character of seasons and the natural dynamics. The concept is derived from the author's sound artwork, *The Sounds of the Wetland*, which was presented as radio art on NTS Radio in London in 2021, following a call for field recordings. In this artwork the soundscape of the lagoon of Avlaimonas between Lefkada island and Acarnanian coast in Greece was presented in relation to the human and tourism noises, biophony and the change of the seasons.

Participants in this workshop were introduced to the concept of biophony, which is defined as the vital communication system used by animals in their society. They were encouraged to adopt a listening-active citizenship stance (the concept of the listening citizen was derived from an article by Brandon Labelle (2024)). The educational processes are linked to pedagogical strategies of *transformative sustainability education*. In this case the focus is not on environmental protection per se, but on the deep relationship between humans and the environment. This is achieved through an action-oriented pedagogy that cultivates emotional changes, critical

participation and collaboration and independent judgment (Corres, et. al, 2020). In this workshop the ability to act is developed through the understanding of the structure and production of the soundscape.

4. Acoustic justice and natural dynamics (implementation)

4.1. Significance of vocal communication

The educational task of the first section of the programme helps participants understand the significance of vocal communication. The initial stage of the programme was to provide an introduction to the key concepts of sound, Acoustic Ecology and Bioacoustics. In accordance with the acoustic justice paradigm, the objective of the second part of this section is to make participants aware of the implications of being *unheard*. It is crucial to consider the potential for sounds to mask or interfere with the human voice, which could result in the alteration of any message that is being conveyed. The participants were invited to introduce themselves, while the remainder of the group engaged in a variety of loud bodily movements, including laughter and conversation. Additionally, the artwork *The Sounds of Wetland* was played through loudspeakers. The participants expressed a range of emotions, including grimaces of wonder and despair, which can be interpreted as an act of symbolising social exclusion. This section was included for the purpose of introducing the concept of noise interfering with acoustic messages, including the phenomenon of masking one's own voice.

Given that all participants resided in villages in close proximity to the Museum area, they were more frequently exposed to the natural environment than students residing in urban areas. All of the participants have experience of animal care, whether as a pet or as part of their parents' farming activities. The aim was to familiarize children with biophony as heard in their daily environment. The students were asked to indicate whether they had observed the aforementioned animals producing any sound, to describe the meaning of the sound and to imitate it. Most of them were able to distinguish the vocalisations of animals in response to hunger, including meowing, barking and neighing. Some participants identified the sounds made by animals when approached by a stranger, while others discussed the evening song of birds. It was noted that some animals make sounds from their bodies to express positive emotions, such as joy and happiness. Imitation of biophony proved an effective method of creating a pleasant atmosphere in the Museum.

Subsequently, the participants were invited to imitate the vocalisations of their own pets or animals, as if the animals were calling them by their name. The children were encouraged to use their acoustic imagination in order to express the animals' calls. This activity helped the students to understand that every animal has a distinctive voice and that this is used to share messages in a different way to human verbal communication.

4.2. Why biophony?

The next section aims to show how the acoustic communication of biofauna unfolds. Specific video examples⁷⁶ were presented that show the purpose of biophony. Sound is a product of the social behaviour of animals (Plait & Krause, 1999; Hart, 1996). Animals produce sounds to navigate and orient themselves in space, to move and to communicate specific sound signals related to: mate attraction, territorial arrangements, danger, predator-prey interaction, family communication, group coordination (Sueur, et al. 2021). Through the video examples children also learnt Bernie Krause's 'Acoustic Niche Hypothesis' (1987): for an animal to be heard its' sound has a specific frequency or temporal niche. They also listened to the Bernie Krause installation, *The Great Animal Orchestra* (2021). By understanding the function of nature, what biophony means, the students became familiar with the soundscapes of the natural ecosystem. This was the key principle to introduce them to sustainability through sound and listening.

4.3. Anthrophony vs Biophony

This section is concerned with the phenomenon of the masking of biophony by human generated noise, which can result in the silencing of entire ecosystems. It focuses on the scientific field of Bioacoustics and draws upon the research of Bernie Krause.⁷⁷ In particular, one of his lectures was presented, showing how a logging factory

⁷⁶ Cornell Lab of Ornithology *The Language of Birds* https://www.youtube.com/watch?v=1X5WMu_oJnQ

Bernie Krause *Do Animals Grieve for the Dead?* <https://www.youtube.com/watch?v=b5uzpLXrQx0>

⁷⁷ Bernie Krause *The Voice of the natural world*. Tedextalk <https://www.youtube.com/watch?v=uTbA-mxo858>

has caused a forest to lost its voice and become silent. Children listened to the sound artwork *Dark Sound* (2016) by Mikel R. Nieto that documents the effects of oil industry on the soundscape of the Amazon rain forest in Ecuador.

In addition, the role of biophony as a climate indicator was considered. The children discussed their experiences of the sound of cicadas, which is the soundmark of the Greek summer. It is recognised that the presence of cicadas is an indicator of a heat. Listening to the sound of cicadas is accompanied by a perception of the environmental temperature (Feld, 2024). In particular, students were asked if they have associated animal and bird sounds with different seasons. The answers related to the sounds of cicadas, nightingales, sheep and cats in breeding season. The children were asked to draw each of the seasons according to the biophony that could be heard. They then drew how they imagined the human noise would mask the aforementioned sounds as well as to express their feelings regarding this potential effect.

It was thus understood that each season has its own distinctive acoustic character. Sound serves as an indicator of climate. If human-generated noise masks biophony, then the seasons and climatic conditions will undergo a change in their sonic identity and will no longer have their own distinctive acoustic signature. Nowadays the heat of summer is characterized by the immersion into the cicadas' soundscape, in the future the loss of the sonic identity of the seasons as a result of human noise will lead to an immersion into a silent natural world. In addition to understanding the role of human noise, students demonstrated an awareness of the concept of environmental sound as a network of interacting and influencing sounds. This approach enabled the students to develop critical thinking skills and foster empathy. By engaging with sound and listening, students can actively contribute to the development and implementation of sustainability policies.

4.4. Embodying the biophony through field recording

The field recording of the Museum environment was undertaken in order to introduce children to the practices of environmental sound art. To begin with, a walk around the museum was conducted, some students were tasked with recording with the portable recorder, while others concentrated on listening and writing down the sound sources for a better understanding of the environment. The quietest places and the noisiest near the road were recorded. Field recording acts a representation of the natural world. It enhances awareness of both natural sounds and listening (Talianni, 2020). In the view of sound anthropologist Steven Feld (2013), field recording represents a means of achieving aural co-presence with the natural world; engaging in a process of deep listening. It is a methodology that investigates the relationship between humans and animals. It fosters attentive listening and socio-political engagement. Consequently, the field recording method allows us to gain insight into the relationship between anthrophony and biophony. It is a way to embody the social acoustic communication of animals. As a result, through field recording students can understand sound sociality through sound materiality.

5. Acoustic justice and sustainability (conclusion)

The use of sound as "a change agent" (Barclay, 2013) and/or "as a mode of social communication, sharing environmental awareness" as noted by sound artist John Grzinich, (Jach, 2015, para 6.) is already a practice of ecological sound art. *Acoustic Oiko-topia* advocates for acoustic justice and focuses on the right of everyone/everything to be heard as well as making the role of acoustic communication in the environment and human impact on it audible to the younger generation. The methodology presented emphasises the political aspects of listening in a way that fosters connections between humans and nature and cultivates acoustic collectivity and community engagement through listening. Human activity has an impact on the production of environmental sound so that sonic identity of nature becomes muted. The concept of sustainability through sound can be seen as a link to the anthropologist Tim Ingold's notion of "a world in formation" (2006). The natural soundscape is not regarded as a subject to objectify and to be treated in a predetermined manner by students. The dynamics of ecosystems are highlighted through an ongoing sensory awareness by listening to co-existence.

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Από την Ηχογράφηση Πεδίου σε Υβριδικές Ηχητικές Αφηγήσεις: Οικολογικό Ραδιοφωνικό Ντοκιμαντέρ και Μουσικο-παιδαγωγικές Ηχο-ιστορίες

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Περίληψη

Η παρούσα εργασία διερευνά τις δημιουργικές δυνατότητες μετασχηματισμού των ηχογραφήσεων πεδίου σε οικολογικά ραδιοφωνικά ντοκιμαντέρ και σε εκπαιδευτικές ηχο-ιστορίες. Αξιοποιώντας τον ορισμό του Bill Nichols (1991) για τα ηχητικά ντοκιμαντέρ ως αφηγήσεις βασισμένες σε επιτόπιες ηχογραφήσεις για επιστημονικούς, περιβαλλοντικούς και εκπαιδευτικούς σκοπούς, η μελέτη εστιάζει στη σύνθετη διαδικασία καταγραφής, επιμέλειας και επαναανοηματοδότησης των περιβαλλοντικών ηχοτοπίων.

Η εθνογραφική προσέγγιση στην ηχογράφηση πεδίου αναδεικνύει τη σημασία της τεκμηρίωσης γεω-φωνικών, βιο-φωνικών και ανθρωπογενών ήχων ως αναπόσπαστων στοιχείων του ηχοτοπίου και της πολιτισμικής ταυτότητας ενός τόπου. Η μεθοδολογία περιλαμβάνει την καταγραφή και ταξινόμηση υψηλής πιστότητας ηχητικών δεδομένων από ηπειρωτικές και νησιωτικές περιοχές της Ελλάδας, τα οποία ενσωματώνονται σε αφηγηματικά πλαίσια, δημιουργώντας υβριδικές μορφές ηχητικής αφήγησης και ένα νέο είδος τεκμηρίωσης: το εθνογραφικό οικολογικό ντοκιμαντέρ.

Παράλληλα, εξετάζεται η εκπαιδευτική δυναμική των «ηχο-ιστοριών» (sound-stories και sound-icons) ως εργαλείων μουσικο-παιδαγωγικής και περιβαλλοντικής αγωγής. Μέσα από ασκήσεις ακρόασης και ηχητικής μίμησης, τα παιδιά αλληλεπιδρούν με τους φυσικούς ήχους, αναπτύσσοντας ρυθμικές ικανότητες, δημιουργική φαντασία και οικολογική συνείδηση.

Η εργασία συνεισφέρει στους τομείς της Ακουστικής Οικολογίας, της Εθνομουσικολογίας και της Περιβαλλοντικής Εκπαίδευσης, προτείνοντας καινοτόμες προσεγγίσεις στη χρήση του ήχου ως μέσου κατανόησης, σύνδεσης και ευαισθητοποίησης απέναντι στο πολιτισμικό και φυσικό περιβάλλον.

Λέξεις Κλειδιά

Ηχογράφηση πεδίου, ακουστική οικολογία, υβριδικές ηχητικές αφηγήσεις, ραδιοφωνικό ντοκιμαντέρ, οικολογικό/εθνογραφικό ραδιοφωνικό ντοκιμαντέρ, περιβαλλοντική εκπαίδευση, οικολογική συνείδηση

1. Ηχογράφηση Πεδίου

Η ηχογράφηση πεδίου (field recording) είναι μια πρακτική που χρονολογείται από τη δεκαετία του 1890 με την πρωτοποριακή εφεύρεση του φωνογράφου από τον Thomas Edison και τη δυνατότητα καταγραφής και αναπαραγωγής του ήχου από μια στιβαρή και αρκετά αξιόπιστη, για τα τότε δεδομένα, κατασκευή (Sterne, 2003:27). Παρότι ο όρος *ηχογράφηση πεδίου* εμφανίστηκε περίπου τέσσερις δεκαετίες αργότερα (Akiyama, 2015:17), συνεχίζει να χρησιμοποιείται με σχετική επιφυλακτικότητα και χωρίς να διαθέτει ένα σαφές πλαίσιο ή έναν κοινώς αποδεκτό ορισμό (Akiyama, 2015:20).

Πάντως, η πρακτική της ηχογράφησης πεδίου (*in situ-επιτόπια*-) έχει αναδειχθεί ιδιαίτερα τις τελευταίες δεκαετίες, με τη χρήση της από ακαδημαϊκούς, ερευνητές και καλλιτέχνες ως μεθοδολογικό εργαλείο της

Βιολογίας, της Περιβαλλοντικής Επιστήμης, της Εθνογραφίας, της Εθνομουσικολογίας, της Πολιτισμικής Ανθρωπολογίας, της Οπτικής Εθνογραφίας, της Οπτικής Ανθρωπολογίας, της Ηλεκτροακουστικής Μουσικής, του Κινηματογράφου. Κάθε πεδίο ορίζει συγκεκριμένες προδιαγραφές για τη μεθοδολογία καταγραφής και την ποιότητα του ήχου, προσαρμόζοντας τις ηχογραφήσεις πεδίου στις ιδιαίτερες ανάγκες και στόχους του (Akiyama, 2015: 20). Για παράδειγμα, η Erika Brady (1999:7-8), ενώ εξετάζει διεξοδικά τον τρόπο με τον οποίο ο φωνογράφος μετέβαλε τις μεθοδολογικές προσεγγίσεις των εθνογράφων από τη γραπτή στην ηχητική τεκμηρίωση, αξιοποιώντας τη δυνατότητα αυτής της πρωτοποριακής συσκευής για *in situ* ηχογράφιση, αποφεύγει να αναφέρει ή, ακόμη περισσότερο, να ορίσει την έννοια της ηχογράφησης πεδίου.

Επίσης, σύμφωνα με τον Akiyama (2015:21), η *ηχογράφηση πεδίου* τείνει να αποφεύγεται ως όρος στο βιβλίο *The Audible Past: Cultural Origins of Sound Reproduction* του Jonathan Sterne παρότι περιέχει μια σημαντική ενότητα για την καταγραφή πεδίου. Επίσης, στο βιβλίο τους *In the Field: The Art of Field Recording* οι Lane και Carlyle δεν παρέχουν έναν ορισμό της επιτόπιας ηχογράφησης, αν και παρουσιάζουν αυτή την πρακτική διεξοδικά, παίρνοντας συνεντεύξεις από εξέχοντες καλλιτέχνες ήχου που ειδικεύονται στην καταγραφή πεδίου (Lane & Carlyle, 2013:9).

Ο Paul Virostek (2012: 30,9), ο οποίος ειδικεύεται σε καταγραφές πεδίου για τη δημιουργία ηχητικών εφέ και ηχητικών περιβαλλόντων κυρίως για την κινηματογραφική βιομηχανία, αναφέρει ότι η ηχογράφηση πεδίου, η οποία πολλές φορές ονομάζεται *φωνογραφία*, όπως χαρακτηριστικά αναφέρει, είναι η τέχνη της ηχογράφησης στον έξω κόσμο και αποτελεί μια ευκαιρία για καταγραφή εξαιρετικών και μοναδικών ηχητικών δειγμάτων.

Τέλος, ο Tom Western (2018:23) αναφέρει χαρακτηριστικά ότι οι ηχογραφήσεις στο στούντιο είναι «τεχνητές κατασκευές ηχητικής επεξεργασίας, ενώ οι ηχογραφήσεις πεδίου ακούγονται ως η διάφανη αποτύπωση της εξωτερικής πραγματικότητας»⁷⁸. Επίσης, υποστηρίζει ότι οι ηχογραφήσεις πεδίου δεν είναι απλώς ένας τρόπος καταγραφής ήχων στο περιβάλλον, αλλά μια δυναμική πρακτική που συνδέει τον ήχο με την έννοια του τόπου, τη χωρική ταυτότητα και την ανθρώπινη εμπειρία.

Αξίζει να αναφερθεί ότι η χρήση του όρου *φωνογραφία*, σε αντιστοίχιση με τον όρο *φωτογραφία*, ίσως και να αποτυπώνει πληρέστερα τη συγκεκριμένη πρακτική. Στο βιβλίο *The Phonographic Memory: A History of Sound Recording in the Field*, ο Mitchell Akiyama εξετάζει την ανάπτυξη και την πολιτιστική σημασία των τεχνολογιών ηχογράφησης που χρησιμοποιούνται στην εθνογραφία και στην επιτόπια έρευνα. Ο Akiyama (2015) εμβαθύνει στην ιστορική εξέλιξη της ηχογράφησης πεδίου, κάνοντας σε σημεία του βιβλίου του συγκρίσεις μεταξύ φωνογραφίας και φωτογραφίας και στο πώς και τα δύο στοχεύουν να συλλάβουν στοιχεία της πραγματικότητας (ήχος και φως, αντίστοιχα). Εξερευνά πώς η φωνογραφία έχει χρησιμοποιηθεί ως εργαλείο τεκμηρίωσης, παρόμοιο με τη φωτογραφία, σε εθνογραφικές και ανθρωπολογικές εργασίες.

Αν και είναι δύσκολο να εντοπίσουμε έναν ξεκάθαρο ορισμό του τι ακριβώς συνιστά η καταγραφή πεδίου, για τους σκοπούς της παρούσας έρευνας, προτιθέμεθα να υιοθετήσουμε τη διατύπωση του Akiyama (όπως αναφέρεται στον Western, 2018) σύμφωνα με την οποία: «η ηχογράφηση πεδίου είναι αυθεντικά θραύσματα ενός μη διαμεσολαβημένου κόσμου, τα οποία έχουν τη δύναμη να διατηρούν ή να εκπροσωπούν τους ανθρώπους και τα φαινόμενα που αντιπροσωπεύουν»⁷⁹. Δηλαδή, οι ηχογραφήσεις πεδίου, λόγω της αντίληψής τους ως αυθεντικών και αδιαμεσολάβητων καταγραφών, συχνά αποκτούν έναν ιδιαίτερο ρόλο ως μέσο διατήρησης πολιτιστικών και φυσικών φαινομένων ή ως υποκατάστατα για τους ανθρώπους και τις εμπειρίες που εκπροσωπούν.

Η ηχογράφηση πεδίου οφείλει να είναι η διάφανη αποτύπωση της εξωτερικής πραγματικότητας. Επίσης, η καταγραφή πεδίου πέρα από τη διαφάνεια της αποτύπωσης, πρέπει να εμπεριέχει την *ταυτότητα του τόπου* και την *αυθεντικότητα της πηγής* κατά την καταγραφή. Ωστόσο, είναι σημαντικό να ληφθεί υπόψη ότι -όπως αναφέρει ο Truax (2001:9)- η διαφάνεια της εγγραφής αποτελεί ένα ιδανικό, το οποίο μπορεί να επιτευχθεί μόνο κατά προσέγγιση και με συμβιβασμούς.

Η παραπάνω ανάλυση καταδεικνύει ότι, ιδανικά, η καταγραφή πεδίου θα πρέπει να χαρακτηρίζεται από υψηλή πιστότητα, ώστε η αποτύπωση να παραμένει διαφανής, δηλαδή να μην γίνεται αντιληπτή η παρουσία της καταγραφικής συσκευής και των μέσων αναπαραγωγής. Το ηχητικό γεγονός που καταγράφεται και αναπαράγεται μέσω μιας καταγραφής πεδίου πρέπει να παραμένει, κατά το δυνατόν, αδιαμεσολάβητο. Με

⁷⁸ Στο πρωτότυπο: "artificial construction[s] of sonic manipulation, while field recordings are heard as the transparent capturing of external reality."

⁷⁹ Στο πρωτότυπο: "Because they are taken to be authentic fragments of an unmediated world, field recordings are often afforded a power to preserve or stand in for the people and the phenomena that they represent."

άλλα λόγια, η διαδικασία της ακρόασης θα πρέπει να είναι απρόσκοπτη, απαλλαγμένη από την αίσθηση της τεχνολογικής παρέμβασης.

Στην κάθε εποχή η πιστότητα σήμαινε κάτι διαφορετικό, είτε στο επίπεδο *τεχνικών προδιαγραφών*, είτε σε επίπεδο του *περιεχομένου*. Σε επίπεδο περιεχομένου, η πιστότητα αναφέρεται στην ομοιότητα μεταξύ πρότυπου και αντίγραφου. Να μην μπορεί να γίνει αντιληπτή η *διαμεσολάβηση της τεχνολογίας* σε κάθε εξελικτικό στάδιο. Η πιστότητα αποτελεί ένα από τα βασικά κομμάτια της ιστορίας της αναπαραγωγής του ήχου και κάθε εξελικτικό βήμα στην τεχνολογία και στον εξοπλισμό προϋπέθετε ή και συνεπαγόταν μια πιο εξελιγμένη μορφή πιστότητας, προσεγγίζοντας τη διαφάνεια του μέσου, δηλαδή τη μη αναγνωρισιμότητα της συσκευής αναπαραγωγής (Sterne, 2003: 222).

Στο ραδιόφωνο, οι ηχογραφήσεις σε φυσικό χώρο υπήρξαν κεντρικής σημασίας για την εξέλιξη του μέσου, ιδιαίτερα στις μορφές του ντοκιμαντέρ (radio drama) και του θεάτρου (radio theater). Οι πρώτοι θεωρητικοί του ραδιοφώνου, ο Rudolf Arnheim (1933: 30-32) και Lance Sieveking (1934: 15-26), αναφέρουν χαρακτηριστικά για τη δημιουργία των «ηχητικών εικόνων» και τον τρόπο με τον οποίο παρουσιάζονται στους ακροατές.

Ωστόσο, η ακρόαση μέσω του ραδιοφώνου συνιστά μια διαμεσολαβημένη εμπειρία, γεγονός που ενισχύει την αντίθεση ανάμεσα στην επιδιωκόμενη αμεσότητα της καταγραφής και την τεχνολογική μεσολάβηση του μέσου αναπαραγωγής. Δηλαδή, από τη μία πλευρά, στοχεύουμε σε μια διάφανη καταγραφή υψηλής πιστότητας, που να επιτρέπει μια άμεση ακουστική εμπειρία αναδεικνύοντας τον τόπο και την αυθεντικότητα της ηχητικής πηγής ή/και του περιβάλλοντος που γίνεται η καταγραφή⁸⁰. Από την άλλη πλευρά, η αναπαραγωγή μέσω ενός έντονα διαμεσολαβημένου μέσου, όπως το ραδιόφωνο, αποκαλύπτει μια βασική διττότητα στον τρόπο προσέγγισης και παρουσίασης των καταγραφών πεδίου και του ηχοτοπίου.

2. Ακουστική Οικολογία και Ραδιοφωνικό Ντοκιμαντέρ

Αν και η εικόνα κυριαρχεί παντού (στα ΜΜΕ, στην πολιτιστική βιομηχανία, στην τηλεφωνία, στις νέες τεχνολογίες), το ραδιόφωνο -ως ήχος χωρίς εικόνα- παραμένει μοναδικό γιατί αποτελεί μέρος του ηχητικού μας σύμπαντος. Αν συνειδητοποιήσουμε, μάλιστα, ότι τα πάντα είναι ήχος (από τη φωνή, την ομιλία, το θόρυβο, την κόρνα, το κελάηδημα, το νερό, τη βροχή, ως τη μουσική και το τραγούδι) κι ότι όλα τα ανθρωπογενή ή άλλα φυσικά ηχοτοπία⁸¹, με τα οποία ασχολείται η Ακουστική Οικολογία⁸², συνιστούν το πολιτισμικό μας περιβάλλον, και κάποια από αυτά μάλιστα (ανα)παράγονται από το ραδιόφωνο, τότε συνειδητοποιούμε, επίσης, ότι το ραδιόφωνο πλαισιώνει ηχητικά την ύπαρξή μας ή αποτελεί και το ίδιο ένα ιδιότυπο ηχοτοπίο.

Ένα ηχοτοπίο μπορεί να είναι πραγματικό ή φανταστικό. Ως φανταστικό ορίζουμε μια «σύνθεση ηχοτοπίου» δηλαδή τη δημιουργία ενός ηχοτοπίου της φύσης ή της πόλης κτλ. με βάση προ-ηχογραφημένο υλικό με τη βοήθεια της τεχνολογίας, από τα αντίστοιχα περιβάλλοντα⁸³. «Το ηχοτοπίο είναι οποιοδήποτε ακουστικό πεδίο μελέτης. Μπορούμε να μιλήσουμε για μια μουσική σύνθεση ως ηχοτοπίο ή για ένα ραδιοφωνικό πρόγραμμα ως ηχοτοπίο ή για ένα ακουστικό περιβάλλον ως ηχοτοπίο» (Schafer, 1994: 7). Στην απόδοση του Schafer, το ηχοτοπίο αναφέρεται σε «μια συνολική κοινωνική έννοια, που περιγράφει το πεδίο των ήχων σε έναν συγκεκριμένο τόπο ή σε έναν ολόκληρο πολιτισμό» (Sterne, 2012: 91). Ένας τέτοιος ορισμός απαιτεί όχι μόνο τον ήχο μέσα στον χώρο αλλά και έναν ακροατή σε θέση να τον ακούσει. Όπως το θέτει ο Steven Connor, «ένα ηχοτοπίο είναι ένας ήχος συν ένα ορισμένο είδος σχέσης» (2014: 18). Η σχέση αυτή ορίζεται από ένα πλήθος επιστημονικών πεδίων, που μελετούν το ηχητικό περιβάλλον: (Ακουστική) Οικολογία, Αρχιτεκτονική, Γεωγραφία, Ανθρωπολογία, Ψυχολογία, Παιδαγωγική, Ηχητικές Τέχνες, Φυσική Ακουστική, Μουσική (Σχοινά, 2015), ενώ σύμφωνα με τον Μάκη Σολωμό η μουσική και η ηχητική τέχνη διέπονται από *περιβαλλοντικές*,

⁸⁰ Οι ηχογραφήσεις πεδίου μέσω της εξειδικευμένης καταγραφής του ηχοτοπίου αναδύουν τον ήχο ενός τόπου, συμβάλλοντας στη δημιουργία μιας ακουστικής ταυτότητας για έναν τόπο.

⁸¹ Ο όρος *ηχοτοπίο (soundscape)* εισήχθη στην επιστήμη της Ακουστικής Οικολογίας από τον Murray Schafer, στις αρχές της δεκαετίας του 1970. Ο ίδιος ορίζει το ηχοτοπίο ως «οποιοδήποτε τμήμα του ηχητικού περιβάλλοντος, το οποίο θεωρείται ως πεδίο μελέτης» (Schafer, 1977/1994: 274). Η Pauline Oliveros, συνθέτρια ηλεκτρονικής μουσικής, όρισε τον όρο *soundscape/ ηχοτοπίο* ως «όλες οι ηχητικές κυματομορφές που έχουν περάσει στον φλοιό του εγκεφάλου, από το αυτί μαζί με τους μηχανισμούς του» (2005). Βλ. επίσης Ετμεκτσόγλου, Ι. (2019), «Ηχοτοπία στα οποία ζούμε: Ευρώπη 2019» στο Ετμεκτσόγλου Ι., Διονυσίου Ζ., Μνιέστρης Α. (2019). *Για μια εκπαίδευση βασισμένη στον ήχο. Ακούγοντας, κατανοώντας και συν-δημιουργώντας το ηχοτοπίο στο οποίο ζούμε*.

⁸² Η Ακουστική Οικολογία εδραιώθηκε ως νέα επιστήμη το 2009 (Farina, 2014).

⁸³ Οι πρώτες συνθέσεις ηχοτοπίων δημιουργήθηκαν από Καναδούς συνθέτες τη δεκαετία του 1970 ως αντίπαλο δέος στην ηχορύπανση, η οποία είχε αρχίσει να επικαλύπτει τους φυσικούς ήχους στα αστικά περιβάλλοντα (Ετμεκτσόγλου, 2014).

πνευματικές και κοινωνικές οικολογίες, τις οποίες καλείται ο συνθέτης και ο ερευνητής να ανακαλύψει (Solomos, 2023).

Σε οποιαδήποτε θεσμικό και κανονιστικό πλαίσιο κι αν ανήκει το ραδιόφωνο (κρατικό, ιδιωτικό, δημοτικό, θεματικό, πειραματικό κ.λπ.) και με οποιοδήποτε περιεχόμενο, ακόμη και στη σοβαρότερή του μορφή, όπως το ντοκιμαντέρ, το ραδιόφωνο συνιστά, κατά τον W. Ong (1982: 86-88), μια μορφή προφορικότητας και επικοινωνίας και μάλιστα ολοένα μεταλλασσόμενη.

Ένα ντοκιμαντέρ μπορεί να είναι ακουστικό/ οπτικό/ οπτικο-ακουστικό. Βασικό του χαρακτηριστικό είναι η λεκτική ή εξω-λεκτική αφήγηση, που βασίζεται σε τεκμήρια με εκπαιδευτικό, ενημερωτικό, καταγραφικό σκοπό (Nichols, 1991). Στην περίπτωση του ντοκιμαντέρ, ως ηχητικό ντοκουμέντο, ως ραδιοφωνικό ντοκιμαντέρ (το οποίο πρωτοεμφανίστηκε στην Αμερική ήδη από το 1930, με τη μορφή συνεντεύξεων) είναι ένα είδος καταγραφής και ηχητικής τεκμηρίωσης της ιστορίας, του πολιτισμού, των προσώπων (αν πρόκειται για αφιέρωμα σε προσωπικότητες), του περιβάλλοντος, ακόμη και της καθημερινότητάς μας.

Άρα, το ραδιοφωνικό ντοκιμαντέρ είναι ένα ραδιοφωνικό έργο *τεκμηρίωσης*, που διέπεται από τις συμβάσεις και τους όρους της ραδιοφωνίας, με *οργανωμένη αφήγηση*, καθώς και από τις συμβάσεις των έργων τεκμηρίωσης (ντοκιμαντέρ), που εν προκειμένω περιλαμβάνουν και ηχητικά τεκμήρια-ντοκουμέντα. Τα τεκμήρια αυτά μπορούν να παρέχουν πληροφορίες φυσικού, πολιτισμικού και ιστορικού περιεχομένου, και μπορεί να είναι: φυσικοί ήχοι (φυσικά φαινόμενα, πουλιά, ζώα, ανθρωπογενείς), ιστορικοί ήχοι (πόλεμος, μάχες κ.λπ.), πολιτισμικοί ήχοι (τελετουργία, έθιμα, δρώμενα, καμπάνα κ.λπ.), θόρυβοι (μη επιθυμητοί, ακαθόριστοι ήχοι), μηχανικοί ήχοι (μηχανή, αυτοκίνητο, εργοστάσιο) λόγος (ομιλία/ αφήγηση/ συνέντευξη/ διάλογος), μουσική ή/και ηχητικός σχεδιασμός (ως οργανωμένη ηχητική τέχνη, με κανόνες αρμονίας, ύφους, με ρυθμό και επιλογή μουσικών οργάνων και με αισθητική συγκρότηση, το τελευταίο κυρίως για τον ηχητικό σχεδιασμό/ sound design).

3. Οικολογικό ραδιοφωνικό ντοκιμαντέρ - Μελέτη Περίπτωσης

Το ραδιοφωνικό ντοκιμαντέρ, που στηρίζεται σε ηχογραφήσεις πεδίου ή *φωνογραφίες* (Virostek, 2012: 30 και Akiyama, 2015), περιέχοντας ηχοτοπία που συναντάμε στο φυσικό περιβάλλον, ήτοι γεωφωνίες (ήχους από τη φύση), βιοφωνίες (ήχους από ζώα) και ανθρωποφωνίες (ήχους από ανθρώπους)⁸⁴, τα οποία εξετάζει η Ακουστική Οικολογία, συνιστά ένα είδος ηχητικής τεκμηρίωσης του ίδιου του οικοσυστήματος/ του φυσικού περιβάλλοντος, και προϋποθέτει την πρότερη ηχητική αποτύπωση αυτού *in situ*, μέσω της ηχογράφησης/ φωνογραφίας. Υπ' αυτήν την έννοια, ένα τέτοιο ντοκιμαντέρ θα μπορούσε να ονομαστεί *οικολογικό ραδιοφωνικό ντοκιμαντέρ*, όρος που αποτελεί νέα κατάθεση της γράφουσας, Ρ. Δαλιανούδη, στις Επιστήμες της Ακουστικής Οικολογίας και των Media Studies, παραπέμποντας επί της ουσίας στο δεύτερο συστατικό της Ακουστικής Οικολογίας. Το *οικολογικό ντοκιμαντέρ* είναι στην ουσία ένα εθνογραφικό⁸⁵ ντοκιμαντέρ, μόνο που εδώ δίνεται έμφαση στο *φυσικό περιβάλλον* και το ηχοτοπίο του, με ή χωρίς την ανθρώπινη ύπαρξη, ενώ στο εθνογραφικό ντοκιμαντέρ ο ερευνητής εστιάζει κυρίως στους ανθρώπους, στις πράξεις και τις διηγήσεις του στο πλαίσιο μιας τοπικής κοινωνίας ή κοινότητας.

Λόγω της φύσης του μέσου, που αναπαράγει ηχογραφημένο υλικό, το οικολογικό ντοκιμαντέρ διαμεσολαβεί το ηχογραφημένο περιβάλλον και κατά συνέπεια τον πολιτισμό μας, μέσω ενός δημοφιλούς μέσου μαζικής ενημέρωσης: το ραδιόφωνο. Όσο πιο πιστή είναι η αποτύπωση/ ηχογράφηση του ηχοτοπίου στο πεδίο, και όσο η παρουσία της καταγραφικής συσκευής και του εξοπλισμού είναι διαφανής, τόσο πιο αληθινή/ πιστή θα είναι και η *αναπαραγωγή* του ηχοτοπίου σ' ένα μέσο. Από την άλλη, όσο πιστή και να είναι μια ηχογράφηση και αποτύπωση του ηχοτοπίου, η ραδιοφωνική του αναπαραγωγή είναι αναπόφευκτα συνυφασμένη με τη διαμεσολάβησή του υλικού αυτού τόσο σε τεχνικό επίπεδο (αναπαράγεται από άλλο μέσο από αυτό με το

⁸⁴ Σύμφωνα με τον Murray Schafer (1977), οι ήχοι στο φυσικό περιβάλλον χωρίζονται σε τρεις κατηγορίες, που συνιστούν το ηχοτοπίο: α. Βιο-φωνίες (οι ήχοι των ζώων), β. Γεω-φωνίες (οι ήχοι της φύσης, γεωφυσικά στοιχεία), γ. Ανθρωπο-φωνίες (ανθρωπογενείς ήχοι). Βλ. επίσης Farina Almo (2014:1).

⁸⁵ Το εθνογραφικό -ραδιοφωνικό ή τηλεοπτικό- ντοκιμαντέρ χρησιμοποιείται κατά βάση από τις επιστήμες της Εθνογραφίας, Λαογραφίας, Εθνομουσικολογίας, Εθνοχορολογίας, της Οπτικής Λαογραφίας, Οπτικής Ανθρωπολογίας, που χρησιμοποιούν τη μέθοδο της καταγραφής «στο πεδίο»/ «in situ». Ο σκοπός της εθνογραφικής καταγραφής και μελέτης δεν είναι μόνο σωστικός αλλά ερμηνευτικός: προκύπτει από τα βασικά ερωτήματα που θέτουν οι επιστήμες πεδίου: *τι; πού; ποιος; πότε; πώς; και γιατί;* (Δαλιανούδη, 2020: 34 και 333). Η καταγραφή «in situ» γίνεται με επαυξημένα εργαλεία καταγραφής και παρατήρησης: ψηφιακούς καταγράμεις ήχου, φωτογραφική μηχανή, βιντεοσκόπηση, ειδικά μικρόφωνα, ειδικά εξαρτήματα. (Bernard and Cravlee, 2015: 442. Cámara de Landa et al., 2015).

οποίο αρχικά καταγράφηκε), όσο και σε καλλιτεχνικό - σκηνοθετικό επίπεδο (υπάρχει η αισθητική του ραδιοφωνικού σκηνοθέτη-παραγωγού).

Το ηχοτοπίο αποτελεί έναν σημαντικό παράγοντα για την κατανόηση του χωροχρόνου, καθώς παρέχει πληροφορίες σχετικά με την εποχή κατά την οποία πραγματοποιήθηκε μια ηχογράφηση, τις κλιματικές, κοινωνικές και πολιτισμικές συνθήκες που επικρατούσαν, καθώς και το πλαίσιο μέσα στο οποίο έλαβε χώρα η καταγραφή. Επιπλέον, συμβάλλει στον προσδιορισμό του αν η ηχογράφηση έγινε σε εξωτερικό περιβάλλον ή σε στούντιο. Σύμφωνα με τον Michael Southworth οι ήχοι και επομένως η ηχογράφηση σε εξωτερικό χώρο, όπως σε ένα αστικό περιβάλλον, επηρεάζουν την αντίληψη και την εμπειρία του ατόμου από τον χώρο αυτό, καθώς αποτελούν μέρος του ευρύτερου χωροταξικού σχεδιασμού (Southworth, 1969: 49-70). Αντίστοιχα, η ηχογράφηση σε ένα «προστατευμένο» από άλλους ήχους/ θορύβους, ειδικό περιβάλλον (όπως είναι τα studios), μπορεί να αποτελέσει ιδανική συνθήκη ηχογράφησης αν πρόκειται για δισκογραφία ή για μια συμβατική εκπομπή, αλλά χάνεται όλη η άλλη ηχητική πληροφορία από το φυσικό/ εξωτερικό περιβάλλον λόγω του «αποστειρωμένου» στουντιακού περιβάλλοντος.

Εδώ γεννιούνται τα εξής ερευνητικά ερωτήματα: Μπορούν οι ηχογραφήσεις πεδίου στη φύση ή σ' ένα παραδοσιακό χωριό, να γίνουν ραδιοφωνικό εθνογραφικό οικολογικό ντοκιμαντέρ; Μπορεί να μετατραπεί μια οπτική πληροφορία σε ακουστική; Πώς λειτουργεί αυτή η υβριδική ηχητική αφήγηση;

Στην πράξη φαίνεται ότι οι απαντήσεις στα δύο βασικά ερωτήματα είναι καταφατικές, με τις εξής όμως προϋποθέσεις: Το ραδιοφωνικό εθνογραφικό οικολογικό ντοκιμαντέρ οφείλει να ακολουθεί τους κανόνες των εκπομπών τεκμηρίωσης (ντοκιμαντέρ), δηλαδή να περιλαμβάνει μια περιγραφική λεκτική αφήγηση, με αρχή, μέση και τέλος, η οποία θα συνδυάζεται/ εναλλάσσεται με την ακουστική αφήγηση από τα ηχητικά τεκμήρια (ντοκουμέντα) από τις καταγραφές πεδίου. Η περιγραφική λεκτική αυτή αφήγηση του παραγωγού ή παρουσιαστή του ραδιοφωνικού ντοκιμαντέρ ανήκει στις εξω-διηγητικές αφηγήσεις (όπως ισχύει και στον κινηματογράφο), εφόσον απευθύνονται στους ακροατές και δεν αποτελούν μέρος των καταγεγραμμένων ηχητικών ντοκουμέντων/ ηχοτοπίων (Gennette, 1972/2007)⁸⁶. Σ' αυτές τις περιπτώσεις, οι εξω-διηγητικές αφηγήσεις (voice-over) ηχογραφούνται ετεροχρονισμένα, δηλ. σε διαφορετικό χρόνο από τον χρόνο ηχογράφησης στο πεδίο, και μάλιστα σε εντελώς διαφορετικές συνθήκες: στο φυσικό περιβάλλον οι επιτόπιες καταγραφές, και στο στούντιο οι επεξηγηματικές περιγραφές του παραγωγού ή παρουσιαστή. Παράδειγμα το ηχητικό ντοκιμαντέρ της Hildegard Westerkamp, όπου την ακούμε να περιγράφει στην αρχή ποια είναι, τι κάνει και τι θ' ακούσουμε στο ντοκιμαντέρ⁸⁷.

Υπάρχουν, όμως, και περιπτώσεις, που η λεκτική περιγραφική αφήγηση σ' ένα ραδιοφωνικό ντοκιμαντέρ μπορεί να είναι εσωτερική, με την έννοια ότι ηχογραφείται μαζί με τα ηχητικά ντοκουμέντα χωρίς όμως να ανήκει σε αυτά, αποτελώντας ένα διακριτό μέρος των ηχητικών ντοκουμένων, το οποίο δεν μπορούν να ακούσουν οι τυχόν συμμετέχοντες (αν πρόκειται για συνεντευξιαζόμενους ή για μουσικούς που παίζουν σε ένα πανηγύρι κ.λπ), αλλά δεν απευθύνεται σε αυτούς. Μια τέτοια περίπτωση ακούμε στο ραδιοφωνικό ντοκιμαντέρ "Kits Beach Soundwalk" της Hildegard Westerkamp (1989), η οποία περιγράφει και επεξηγεί το φυσικό περιβάλλον (εν προκειμένω παραθαλάσσιο). Η αφήγησή της, ενδοδιηγητική – ετεροδιηγητική,⁸⁸ είναι ταυτόχρονη με τα ηχητικά ντοκουμέντα του φυσικού περιβάλλοντος, λειτουργεί όμως σ' ένα παράλληλο ηχητικό πλαίσιο και σε διαφορετικό αφηγηματικό επίπεδο από αυτό του ηχοτοπίου, που σαφώς δεν ανήκει στους ανθρωπογενείς ήχους της επιτόπιας καταγραφής και απευθύνεται στους μελλοντικούς ακροατές της εν είδει «φωνητικού ημερολογίου» ή και στην ίδια για λόγους διευκόλυνσης της μνήμης.

Σε ό,τι αφορά τη μεταφορά των οπτικών πληροφοριών σ' ένα μέσο μη οπτικό, η ραδιοφωνική εκφώνηση (speakage), αφού δεν υπάρχει εικόνα, οφείλει να περιγράψει συμπτυκνωμένα, όσα στοιχεία θα έβλεπαν οι ακροατές αν υπήρχε τηλεοπτικός πομπός ή αν ήταν παρόντες στην ηχογράφηση: τον χώρο, το περιβάλλον, τις συνθήκες, την εποχή, την ημερο-χρονολογία, την περίσταση ή την αφορμή, το πόσοι και ποιοι συμμετέχουν, την ιδιότητα και την αφορμή για τη συμμετοχή τους, τα μουσικά όργανα και τον τεχνολογικό εξοπλισμό.

Έπειτα, ο ραδιοφωνικός παραγωγός/ σκηνοθέτης, έχοντας στη διάθεσή του όλο το οπτικό και ακουστικό υλικό από την επιτόπια καταγραφή, σκηνοθετεί την ηχητική του αφήγηση, επιλέγοντας και συνθέτοντας (με όρους τεχνικούς: μοντάρνοντας) τα αποσπάσματα που εξυπηρετούν την αφήγησή του, δημιουργώντας μια

⁸⁶ Ο Γάλλος θεωρητικός Gerard Gennette στο έργο του *Discours du récit* (1972) ανέπτυξε ένα αναλυτικό σχήμα της αφήγησης, μιλώντας για διαφορετικά επίπεδα αφήγησης και τύπους αφηγητή.

⁸⁷ Hildegard Westerkamp, Luis Velasco Pufleau (2022). *Listening is action. A soundwalk with Hildegard Westerkamp*. Διαθέσιμο στο: <https://www.youtube.com/watch?v=CnkzZAaaAIU>.

⁸⁸ Ενδο-διηγητική γιατί δεν είναι εξωτερική, αλλά μέσα στην καταγραφή του ηχοτοπίου, και ετερο-διηγητική γιατί δεν ανήκει στο ηχοτοπίο του φυσικού περιβάλλοντος που καταγράφει.

ραδιοφωνική αφήγηση, που μπορεί να εμπλουτιστεί με επεξηγηματικό ή ποιητικό λόγο, ακόμη και με άλλες μουσικές. Σε μερικές περιπτώσεις του Radio on Demand ή του ψηφιακού αρχείου ήχου Podcast (Personal On Demand BroadCast), η ηχητική πληροφορία μπορεί να συνδυαστεί με στατικές φωτογραφίες⁸⁹ από το πεδίο καταγραφής του ηχοτοπίου, που ενισχύουν την ηχητική πληροφορία χωρίς να κλέβουν την παράσταση από τον ραδιοφωνικό ήχο. Παράδειγμα οι φωτογραφίες που έβαλε η Westerkamp στο ραδιοφωνικό της ντοκιμαντέρ "Kits Beach Soundwalk" (1989).

Η μελέτη περίπτωσης οικολογικού ραδιοφωνικού ντοκιμαντέρ αναφέρεται στις καταγραφές πεδίου και στις συνεντεύξεις πληροφορητών στη νήσο Κέα (Τζια)⁹⁰. Το έργο περιλάμβανε την παραγωγή δέκα αυτοτελών τηλεοπτικών ντοκιμαντέρ, επικεντρωμένων στην καταγραφή των εναπομεινάντων ηλίκιωμένων παραδοσιακών οργανοπαιχτών με την παλιά νησιωτική ζυγιά, τσαμπούνα και τουμπί, της Κέας, καθώς και στη μεταλαμπάδευση της παράδοσης στη νεότερη γενιά και συγκεκριμένα στους απογόνους (παιδιά ή/και εγγόνια) αυτών των σημαντικών παραδοσιακών μουσικών του νησιού. Τα ντοκιμαντέρ εστίασαν στο παίξιμο των παραδοσιακών αυτών μουσικών, στο τοπικό μουσικό ιδίωμα και στον προσωπικό τρόπο παιξίματος, στο τοπικό ρεπερτόριο (τραγούδια και σκοποί), με ζωντανές ερμηνείες, ενώ εμπλουτίστηκαν και με ατομικές συνεντεύξεις των οργανοπαιχτών, όπως και με αφηγήσεις παλαιών ιστοριών (μνήμες), που συνδέονται με τοπικές γιορτές και πανηγύρια. Ιδιαίτερη έμφαση δόθηκε στην καταγραφή των μουσικών στο «φυσικό» τους περιβάλλον (in situ), είτε ήταν στο παραδοσιακό χοροστάσι (αυλή σπιτιού, ή στον αυλόγυρο της εκκλησίας ή μέσα στη φύση), αντί σε studio ηχογράφησης, προκειμένου να αποτυπωθεί «αυθεντικά» και αυθόρμητα η σχέση τους με το παραδοσιακό χοροστάσι, αλλά και με το ίδιο το τοπίο. Η παρουσία του φυσικού περιβάλλοντος του νησιού στις ηχογραφήσεις πεδίου ανέδειξε το περιβάλλον και το μέρος (χωριό) ως τοπόσημο, τα ηχοτοπία του ως *ηχώσημα*, και κατέδειξε τη συμβολή του περιβάλλοντος στη διαμόρφωση της μουσικής ταυτότητας του τόπου.

Μια ακόμη βασική επιδίωξη αυτής της δράσης ήταν η καταγραφή όχι μόνο των ερμηνειών των μουσικών, αλλά και η αιχμαλώτιση όλου του ηχητικού πλαισίου, του ηχοτοπίου κάθε περιοχής, δηλαδή των χαρακτηριστικών «συνοδευτικών» ήχων (των ήχων δηλαδή που -με όρους μουσικούς- συνοδεύουν τη φυσική εικόνα και που δεν είναι προκαθορισμένοι και προβλέψιμοι), οι οποίοι αποτελούνται από το φυσικό τοπίο, τις κλιματικές και γεωφυσικές συνθήκες (τζιτζίκια, αιγοπρόβατα, αέρας, σε υψόμετρο ή κοντά σε παραλία), τις παραδοσιακές πολιτισμικές πρακτικές (καμπάνα εκκλησίας κ.ά.) και την εκούσια ή ακούσια ανθρώπινη παρέμβαση. Ακριβώς επειδή στο εγχείρημα αυτό, δόθηκε βαρύτητα στην καταγραφή και ανάδειξη του τοπικού παραδοσιακού ρεπερτορίου από τους «δεξιότεχνες»⁹¹ πρακτικούς μουσικούς, και μάλιστα σε εμβληματικά – από λαογραφική και μουσική άποψη– τοπόσημα της Κέας (Ιερά Μονή Καστριανής, Άγιος Συμεών, αυλές σπιτιών στην Ιουλίδα, αλλά και φυσικά περιβάλλοντα/μέρη, όπως η Βρύση του Βενιαμίν, η παραλία στις Πίσσες, ο Ιερός Ναός της Αγίας Ειρήνης στο Βουρκάρι) και σε περίοδο με πλούσιο φυσικό ηχητικό υλικό (βιο-φωνίες και γεω-φωνίες καλοκαιριού), το καταγεγραμμένο ηχητικό υλικό καλύπτει δύο θεμελιώδεις άξονες της δράσης, που δεν είναι άλλοι από την αυθεντικότητα και την πρωτοτυπία.

Το φυσικό ηχοτοπίο, ηχογραφημένο με όσο το δυνατόν μεγαλύτερη διαφάνεια και πιστότητα, ενσωματωμένο στα ντοκιμαντέρ ως ηχητικό υπόβαθρο, συνέβαλε στη δημιουργία μιας πολυδιάστατης και βιωματικής απεικόνισης του οικοσυστήματος, το οποίο διαμεσολαβείται μέσα από το ραδιόφωνο, ενισχύοντας τη σύνδεση του μουσικού έργου με το ίδιο το περιβάλλον, προσδίδοντας στο ντοκιμαντέρ υψηλή προστιθέμενη αξία.

Εν προκειμένω, για την παραγωγή του ραδιοφωνικού οικολογικού ντοκιμαντέρ επιλέχθηκαν 5 αποσπάσματα από το σύνολο των καταγραφών, που μαρτυρούν και τεκμηριώνουν τα εξής: α) ότι η ηχογράφηση και οι συνεντεύξεις έγιναν στο μέσο του καλοκαιριού (τζιτζίκια και κύμα), β) ότι η ηχογράφηση έγινε σε εξωτερικό χώρο (αεράκι και εξωτερικοί ήχοι), γ) ότι οι παραδοσιακές ζυγίες που ακούγονται είναι: νταούλι με τουμπί, και

⁸⁹ Σε σπάνιες περιπτώσεις, αντί για στατικές φωτογραφίες το podcast μπορεί να εμπεριέχει βίντεο, οπότε μετονομάζεται σε vodcast ή vidcast. (Στην αρχή κυρίως υπήρχε η πρακτική του να βιντεοσκοπεί ο παραγωγός τη διαδικασία εγγραφής του podcast. Αργότερα το βίντεο μπορεί να είναι το οτιδήποτε, χωρίς όμως να έχει απαραίτητα σύνδεση με το περιεχόμενο του ηχητικού ντοκουμέντου). Hall & Manfull, 2014 και Hendricks & Mims, 2018.

⁹⁰ Τη συγκεκριμένη δράση με τίτλο: «Καταγραφή παραδοσιακών οργανοπαιχτών της Κέας για τη διάσωση, διατήρηση και ανάδειξη της παραδοσιακής μουσικής ως άυλης πολιτιστικής κληρονομιάς» υλοποίησε η Κοινωφελής Επιχείρηση του Δήμου Κέας, χρηματοδοτούμενη από το μουσείο Κυκλαδικής Τέχνης μέσω του προγράμματος Cycladic Identity.

⁹¹ Μέσα σε εισαγωγικά γιατί ενέχεται ένα οξύμωρο σχήμα. Η δεξιότεχνία σ' ένα μουσικό όργανο προϋποθέτει μακρά και εξειδικευμένη μουσική παιδεία, επαγγελματικού/ σολιστικού επιπέδου, που συναντάται στη συστηματοποιημένη μουσική παιδεία της έντεχνης/ λόγιας μουσικής. Όμως στην προκειμένη περίπτωση, παρότι μιλάμε για πρακτικούς μουσικούς με προφορική και μιμητική διαδικασία μάθησης, δανειζόμαστε τον όρο για να τονίσουμε τη δεξιοτήτά τους λόγω μακραίωνης πρακτικής και τη διαφοροποίησή τους από άλλους ντόπιους πρακτικούς μουσικούς, που δεν είναι αναγνωρισμένοι από την τοπική κοινότητα ως τέτοιοι.

τέλος δ) ότι η μουσική παράδοση μπορεί να εμπνεύσει έναν σύγχρονο δημιουργό να φτιάξει μουσική, ή να δημιουργήσει ηχητικό σχεδιασμό, βασισμένο πάνω στα παραδοσιακά ρυθμο-μελωδικά μοτίβα και τους ήχους των μουσικών οργάνων (τίτλοι αρχής και τέλους, με τη μουσική επένδυση του Αποστόλη Λουφόπουλου)⁹².

4. Οι καταγεγραμμένοι ήχοι της φύσης ως παιδαγωγικό εργαλείο

Ο ήχος και η μουσική, από την αρχαιότητα ήδη, έχουν χρησιμοποιηθεί από τους αοιδούς-ποιητές και παιδαγωγούς, για να αφηγηθούν ιστορίες και να διδάξουν τους νέους. Ο ήχος μπορεί να προκαλέσει συναισθήματα, να προωθήσει την πλοκή μιας ιστορίας, ακόμη και να αναπτύξει χαρακτήρες, όταν οργανώνεται σε ηχητική τέχνη, υπό την έννοια της ακουστικής μαθητείας. Οι ήχοι από το περιβάλλον είναι οικείοι στο ανθρώπινο αυτί γιατί προέρχονται από το ηχητικό μας σύμπαν και πολλές φορές το συμπυκνώνουν χωρικά και χρονικά. Οι δάσκαλοι μουσικής χρησιμοποιούν ποικίλες μεθόδους για να διδάξουν στους μαθητές πώς η μουσική και οι ήχοι λειτουργούν ως φορείς νοημάτων και ιδεών (Errpink, 2008).

Μελέτες έχουν βρει ότι η ενίσχυση της διδασκαλίας των σημασιών των λέξεων με μη λεκτικά βοηθήματα και ερεθίσματα, ιδιαίτερα εικόνες, χειρονομίες, μουσική βοηθά τους μικρούς μαθητές να δημιουργήσουν πλούσιες λεξικές αναπαραστάσεις. Η διδασκαλία και η αφήγηση μέσω της μουσικής, γνωστή ως *ηχητική ιστορία (sound-story)* συνιστά ένα τέτοιο εργαλείο. Η ηχο-ιστορία μπορεί να είναι ένα ποίημα ή ένα σύντομο παραμύθι ή μια προφορική αφήγηση, και μπορεί να περιλαμβάνει διαδραστικές φωνές με ηχητικά εφέ, παίξιμο/ κρούση μουσικού οργάνου σε χαρακτήρες, σκηνές ή λέξεις-στόχους κατά τη διάρκεια της ιστορίας (Andress, 1980; Cardany, 2013). Στις ηχητικές ιστορίες, οι δάσκαλοι επιλέγουν λέξεις-κλειδιά από το κείμενο και στη συνέχεια εργάζονται με τους μαθητές για να ορίσουν ένα ηχητικό εφέ, που απεικονίζει τον τόνο και τη σημασία κάθε λέξης-κλειδιού.

Οι ηχο-ιστορίες (sound-stories) στη μουσική παιδαγωγική, ιδιαίτερα κατά την πρώιμη παιδική ηλικία, αποτελούν μια σημαντική εκπαιδευτική προσέγγιση που μπορεί να ενισχύσει την ανάπτυξη των παιδιών με πολλαπλές μορφές. Τα παιδιά έχουν τη δυνατότητα να αφομοιώνουν νέες πληροφορίες και δεξιότητες μέσω παιχνιδιού και δημιουργικών δραστηριοτήτων, και προσφέρουν ένα πλούσιο περιβάλλον μάθησης.

Οι ηχο-ιστορίες και οι συνεπακόλουθες ηχο-εικόνες, που βασίζονται σε ηχογραφημένους φυσικούς ήχους, όπως ο ήχος της βοής της θάλασσας, του θροΐσματος των δέντρων αλλά και άλλων ηχοτοπίων, είναι ένας εναλλακτικός τρόπος προσέγγισης της μουσικής προς τα παιδιά, καθώς και της ίδιας της φύσης. Είναι ένα μουσικο-παιδαγωγικό παιχνίδι των εκπαιδευτών, για το πώς μπορούν τα παιδιά να γνωρίσουν και να μιμηθούν ήχους από το περιβάλλον, χρησιμοποιώντας τα κρουστά όργανα της τάξης (τύμπανα, ντέφια, μαράκες, ξύστρες, μεταλλόφωνα, ξυλόφωνα⁹³) με πρωτότυπους τρόπους και τη φωνή τους, ώστε να επενδύσουν μουσικά διάφορες ιστορίες. Τα παιδιά ακούν προσεχτικά μια αφήγηση από τη/τον δασκάλα/ δασκαλό τους και επιλέγουν ένα όργανο ή και περισσότερα και προσπαθούν να αποδώσουν αυτό που άκουσαν με ήχους, που να είναι κοντά στον φυσικό ήχο.

Οι ηχο-ιστορίες από ηχογραφήσεις πεδίου είναι μια αυθεντική διαδικασία ενσωμάτωσης ηχητικών ντοκουμέντων στην αφήγηση και εν τέλει στη διδασκαλία, και αποτελεί μια άλλης «ποιότητας» ηχητική αφήγηση, που προάγει την περιβαλλοντική εκπαίδευση και οδηγεί στην οικολογική ευαισθητοποίηση/ συνείδηση των παιδιών. Η κινητική/ χορευτική/ φωνητική/ μουσική αντίδραση των παιδιών στο άκουσμα των ηχητικών ντοκουμέντων, λόγω της αυθόρμητης φύσης τους, όπως και η τάση τους για μίμηση, καθιστούν την όλη εκπαιδευτική διαδικασία δημιουργική και διαδραστική, ενώ η γνώση σε ό,τι αφορά τη γνωριμία τους με το φυσικό περιβάλλον ή/και το ηχοτοπίο ενός συγκεκριμένου τόπου (π.χ. παραθαλάσσιο πάρκο, πανηγύρι σε χωριό, κατασκήνωση σε βουνό) ή μέρους (π.χ. λειτουργία σε μια εκκλησία ή σε μοναστήρι) παρέχεται στοχευμένη. Το αποτέλεσμα είναι ένας συναρπαστικός τρόπος αφήγησης, που προκαλεί τη δημιουργικότητα και τη φαντασία. Σε συνδυασμό με τα μουσικά όργανα, που μπορούν να χρησιμοποιηθούν, τις φωνές των παιδιών και την κινητική συνοδεία, η μάθηση γίνεται πολυαισθητηριακή και πολυεπίπεδη.

⁹² Η λίστα με τα ντοκιμαντέρ, από τα οποία αντλήθηκε το ηχητικό υλικό για την παραγωγή του ραδιοφωνικού ντοκιμαντέρ, βρίσκεται στο *youtube* στη διεύθυνση: <https://cutt.ly/DeF6VjHk>

⁹³ Τα δύο τελευταία όργανα χρησιμοποιούνται κυρίως από τις μουσικο-παιδαγωγούς γιατί προϋποθέτουν μουσικές γνώσεις.

5. Επίλογος

Εν κατακλείδι, η *φωνογραφία* συνιστά τόσο τη διαδικασία της επιτόπιας καταγραφής των ηχητικών ντοκουμέντων από το φυσικό, ανθρωπογενές ή/και μηχανικό ηχοτόπιο, όσο και το ίδιο το περιεχόμενο των ηχητικών ντοκουμέντων από την επιτόπια καταγραφή. Όταν τα ηχητικά αυτά τεκμήρια/ ηχογραφήσεις πεδίου ενσωματωθούν σε -και συνδυαστούν με- αφηγηματικά πλαίσια, μπορούν να δημιουργήσουν *υβριδικές μορφές ηχητικής αφήγησης* (ραδιοφωνική εκπομπή, ραδιοφωνικό ντοκιμαντέρ) και έτσι να συνιστούν ένα νέο είδος τεκμηρίωσης: το *εθνογραφικό οικολογικό ντοκιμαντέρ*, που στηρίζεται στην (Ακουστική) Οικολογία λόγω ηχοτοπίου, στην Εθνογραφία λόγω επιτόπιας έρευνας και στο Ντοκιμαντέρ λόγω ραδιοφωνικού είδους. Μια άλλη υβριδική ηχητική μορφή αφήγησης έχουμε με την ενσωμάτωση αυθεντικών ηχοτοπίων από τις ηχογραφήσεις πεδίου στις εκπαιδευτικές ηχο-ιστορίες, ήδη στην προσχολική και τη σχολική αγωγή, που δίνει τη δυνατότητα στους/στις παιδαγωγούς/ εκπαιδευτικούς να εξοικειώσουν τα παιδιά με την ηχο-ποικιλότητα ενός τόπου και να τα κάνουν να συνδυάσουν τη Γεωγραφία με τη Φυσική Ιστορία και την τοπική Ακουστική Οικολογία. Παράλληλα, οι ηχο-ιστορίες γίνονται κατάλληλα εργαλεία για την υποστήριξη της ολιστικής ανάπτυξης των παιδιών, καθιστώντας τη διαδικασία μάθησης πιο ευχάριστη, αποτελεσματική και με περιβαλλοντικά οφέλη.

6. Αναφορές

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From Field Recording to Hybrid Sound Narratives: Ecological Radio Documentary and Music-Pedagogical Echo-Stories

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Abstract

This study contributes to the fields of Acoustic Ecology, Ethnomusicology and Environmental Education, offering insights into innovative approaches to sonic storytelling and ecological awareness. This paper explores the creative potential of transforming field recordings into ecological radio documentaries and educational audio-stories. Drawing on Bill Nichols' (1991) definition of audio documentaries as narratives based on location sound recordings for scientific, environmental, and educational purposes, the study focuses on the complex process of recording, curating, and recontextualizing environmental soundscapes.

An ethnographic approach to field recording highlights the importance of documenting geophonic, biophonic, and anthropophonic sounds as integral components of soundscapes and the cultural identity of a place. The methodology includes the high-fidelity recording and classification of audio data from both mainland and island regions of Greece, which are embedded into narrative frameworks, giving rise to hybrid forms of sonic storytelling and a new documentary genre: the ethnographic ecological documentary.

Simultaneously, the educational potential of "sound-stories" and "sound-icons" is examined as tools for music pedagogy and environmental education. Through listening and sound-mimicry exercises, children interact with natural sounds, developing rhythmic skills, creative imagination, and ecological awareness.

The study contributes to the fields of Acoustic Ecology, Ethnomusicology, and Environmental Education, proposing innovative approaches to the use of sound as a medium for understanding, connecting with, and raising awareness about cultural and natural environments.

Keywords

Field recording, acoustic ecology, hybrid sound narratives, radio documentary, ecological/ethnographic radio documentary, environmental education, ecological awareness

Ο Υγροβιότοπος της Βραυρώνας: Περιπτωσιολογική Μελέτη Καταγραφής ενός Ηχοτοπίου σε Απειλή

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Περίληψη

Το Μαρκόπουλο αποτελεί έναν σημαντικό βιότοπο άγριας ζωής στην Αττική, με το τοπίο του να έχει παραμείνει σχεδόν αμετάβλητο από την αρχαιότητα. Ωστόσο, σύγχρονα περιβαλλοντικά ζητήματα προκαλούν ανησυχία: η πιθανή μετατροπή των φυσικών όχθων του ποταμού Ερασίνου σε τεχνητές κατασκευές απειλεί την πλούσια βιοποικιλότητα που χαρακτηρίζει αυτή τη σημαντική περιοχή. Η παρούσα μελέτη αφορά στην καταγραφή και ανάλυση των χαρακτηριστικών του υγροβιότοπου της Βραυρώνας και υλοποιήθηκε το 2019, πριν την έναρξη των έργων και παρεμβάσεων στην περιοχή. Ο κύριος στόχος της έρευνας ήταν η συλλογή διαφορετικών τύπων δεδομένων (ηχογραφήσεις, κινηματογραφήσεις και φωτογραφίες), εστιάζοντας στη μελέτη των χωροχρονικών μεταβολών του ηχοτοπίου σε αυτό το μοναδικό οικοσύστημα. Για την ακριβέστερη καταγραφή του υγροβιότοπου και των μεταβολών του κατά τη διάρκεια ενός ετήσιου κύκλου (από τον Μάιο έως τον Δεκέμβριο του 2019), πραγματοποιήθηκαν τέσσερις ηχογραφήσεις – μία για κάθε εποχή – σε τρεις διαφορετικές χρονικές στιγμές της ημέρας (πρωί, μεσημέρι και απόγευμα-σούρουπο). Από την ανάλυση και κατηγοριοποίηση των δεδομένων που συλλέχθηκαν διαπιστώθηκε πως το ηχοτοπίο του Υγροβιότοπου της Βραυρώνας αποτελεί περιβάλλον υψηλής πιστότητας (Hi-Fi), με εξαιρετική ακουστική και αισθητική ποιότητα ήχου. Παρατηρείται υψηλή πυκνότητα και ποικιλία ηχητικών δεδομένων, λόγω της μεγάλης συγκέντρωσης ορνιθοπανίδας στα σημεία καταγραφής.

Λέξεις Κλειδιά

Ηχοτοπίο, καταγραφές πεδίου, ηχογραφήσεις, υγροβιότοπος Βραυρώνας, βιβλιοθήκη ήχων

1. Εισαγωγή - Ο Υγροβιότοπος της Βραυρώνας

Ανάμεσα στην αστικοποιημένη Αρτέμιδα και το ταχέως αναπτυσσόμενο Μαρκόπουλο, ο υγροβιότοπος της Βραυρώνας αποτελεί έναν από τους τελευταίους βιότοπους άγριας ζωής στην Αττική. Σε απόσταση μόλις 30 χιλιομέτρων από την Αθήνα, μέσα σε μια εύφορη πεδιάδα που διέρχεται ο Ερασίνος ποταμός, ο υγροβιότοπος που προστατεύεται από το δίκτυο Natura 2000, παραμένει σχεδόν αμετάβλητος από την αρχαιότητα μέχρι και σήμερα (Σχήμα 1). Η περιοχή έχει ανακηρυχθεί «Τόπος Κοινοτικής Σημασίας (ΤΚΣ)» και ανήκει στις «Ειδικές Ζώνες Διατήρησης (ΕΖΔ)» (Ελληνικό Κτηματολόγιο, 2024).⁹⁴ Η ευρύτερη περιοχή καλύπτεται από ποικιλόμορφη χλωρίδα, αποτελούμενη από θαλάσσια και παράκτια βλάστηση, υγροτοπική βλάστηση, μεσογειακούς θαμνώνες και ενδημικά πευκοδάση που σε συνδυασμό με τη θαλάσσια ζώνη και τα υφάλμυρα νερά αποτελούν

⁹⁴ υπό τον Ν. 3937/2011 (ΦΕΚ 60/Α/31-3-2011, άρθ. 5, παρ. 4).

καταφύγια για τα μικρά ζώα⁹⁵, προσελκύοντας ταυτόχρονα και μεγαλύτερα θηλαστικά⁹⁶ (Ελληνική Ορνιθολογική Εταιρεία, 2021; Ελληνικό Κέντρο Βιοτόπων, 2017). Η μεγάλη ποικιλία διαφορετικών βιοτόπων που ο συγκεκριμένος υγροβιότοπος φιλοξενεί, σε συνδυασμό με τις ήπιες μεθόδους γεωργικής εκμετάλλευσης δημιούργησαν ένα συνεχώς μεταβαλλόμενο σύνθετο υγροτοπικό οικοσύστημα μοναδικής αξίας (Ελληνική Ορνιθολογική Εταιρεία, 2021). Από την αρχαιότητα έγινε αντιληπτή η ιδιαιτερότητα της περιοχής, με τον ναό της Βραυρωνίας Αρτέμιδος να αποτελεί το επιστέγασμα της σημαντικότητας και της σπουδαιότητας της περιοχής (Attica Wetlands, n.d.).

Στις ημέρες μας, άλλο ένα περιβαλλοντικό ατόπημα βρίσκεται σε εξέλιξη, καθώς έχει εγκριθεί και χρηματοδοτηθεί η πραγματοποίηση αντιπλημμυρικών έργων που επηρεάζουν άμεσα την υδρολογική λεκάνη του ρέματος Ερασίνου με πλήθος παρεμβάσεων⁹⁷. Το άστοχο αυτό υποέργο, όπως υποστηρίζεται από τους πλέον ειδικούς, έχει ήδη καταγγελλθεί⁹⁸ από περιβαλλοντικές μη κυβερνητικές οργανώσεις (European Investment Bank Complaints Mechanism, 2023) και ιδιώτες και μέχρι τώρα παραμένει ανοιχτό προς αναθεώρηση, απειλώντας την πλούσια βιοποικιλότητα που καθορίζει αυτή την τόσο σημαντική προστατευόμενη περιοχή φυσικής, βιολογικής και αρχαιολογικής αξίας.



Σχήμα 1. Περιοχή Natura 2000 (GR300419000)

2. Στόχος των Καταγραφών

Η παρούσα εργασία αφορά στην καταγραφή και ανάλυση χαρακτηριστικών σημείων του υγροβιότοπου της Βραυρώνας, όπως καταγράφηκαν το 2019, πριν την έναρξη των σχετικών παρεμβάσεων στην ευρύτερη περιοχή. Ακολουθώντας τις αρχές της Ακουστικής Οικολογίας, επιδιώκεται η ανάδειξη, ευαισθητοποίηση και η μελέτη της σχέσης ανθρώπου - περιβάλλοντος, με μέσο τον ήχο (Wrightson, 2000). Η συγκεκριμένη μελέτη αποτελεί μέρος μιας ευρύτερης προσπάθειας για τη δειγματοληπτική καταγραφή ιδιαίτερων ηχοτοπίων σε περιοχές του ελληνικού χώρου, με έμφαση σε περιοχές που αντιμετωπίζουν αυξημένη περιβαλλοντική πίεση και κινδύνους (π.χ. αστικοποίηση, καταστροφές από πυρκαγιές). Επιδίωξη είναι η ηχητική χαρτογράφηση αυτών των ηχοτοπίων και η δημιουργία ενός ενιαίου ηχητικού χάρτη με το σύνολο των καταγεγραμμένων τοποθεσιών.

⁹⁵ Ενδεικτικά αναφέρονται τα εξής: ψάρια, βάτραχοι, χέλια και άλλα υδρόβια ζώα στη θαλάσσια ζώνη και στα υφάλμυρα νερά του Ερασίνου, πουλιά όπως ερωδιός, μικροτσικνιάς και αηδόνι στους καλαμιώνες, τρυγόνι, συκοφάγος και κούκος σε καλλιεργήσιμες εκτάσεις, αρπακτικά όπως ο φιδαιτός και η αετογερακίνα στους λόφους, γλάροι και αλκυόνες στην παραλιακή ζώνη.

⁹⁶ Νυφίτσα, αλεπού, κουνάβι.

⁹⁷ Στο πλαίσιο του υποέργου του Ερασίνου θα εκτελεστούν οι ακόλουθες εργασίες: διαπλάτυνση των ρεμάτων και επένδυσή τους με συρματοκιβώτια, ενίσχυση των πρανών και της κοίτης, κατασκευή φράγματος ανάσχεσης πλημμυρών (με οχετό ενός ανοίγματος στη βάση του φράγματος) και αναχώματος για την τοπική οδό (με οχετό πολλαπλών ανοιγμάτων) στο ρέμα Ερασίνου (άνω ρους Ερασίνου), κ.ά. (European Investment Bank Complaints Mechanism, 2023).

⁹⁸ Βλ. Σχέδιο Έκθεσης Πορισμάτων «Αντιπλημμυρικά Έργα» (European Investment Bank Complaints Mechanism, 2023).

3. Μεθοδολογία

Η μεθοδολογία βασίστηκε στην συλλογή αποκλειστικά ποσοτικών δεδομένων, όπως ηχογράφηση, και όχι ποιοτικών δεδομένων, όπως τα έντυπα καταγραφής πεδίου, εξαιτίας του μεγάλου πεδίου έρευνας και της δυσκολίας προσέγγισης και καταγραφής. Επιλέχθηκαν επτά χαρακτηριστικά σημεία⁹⁹ (Σχήμα 2) για στατικές δειγματοληπτικές καταγραφές, με βασική επιδίωξη να κυκλωθεί η ευρύτερη περιοχή ώστε να αποτυπωθεί πληρέστερα. Για την καταγραφή επιλέχθηκαν ενδεδειγμένα σημεία παρατήρησης κοντά σε ενημερωτικές πινακίδες (τοποθετημένες στον χώρο από την Ελληνική Ορνιθολογική Εταιρεία), παρατηρητήρια πανίδας και χλωρίδας, αλλά και σημεία με έντονη βιοποικιλότητα για τη συλλογή των διαφόρων ήχων που χαρακτηρίζουν την περιοχή.

Πραγματοποιήθηκαν καταγραφές και στις τέσσερις εποχές, δημιουργώντας έναν *Ετήσιο Κύκλο*¹⁰⁰. Τα τέσσερα ξεχωριστά σύνολα καταγραφών της κάθε εποχής¹⁰¹ αποτελούνταν από τρεις επιμέρους δειγματοληπτικές καταγραφές σε διαφορετικές ώρες της ημέρας (πρωί, μεσημέρι και απόγευμα-βράδυ) (Σχήμα 3), σχηματίζοντας έναν πλήρη *Ημερήσιο Κύκλο*¹⁰². Ακολουθώντας τη συγκεκριμένη προσέγγιση, καταγράφηκαν ογδόντα τέσσερα (84) διακριτά δείγματα ηχητικού και οπτικού υλικού, τα οποία συντέλεσαν στην ακριβέστερη αποτύπωση των εποχικών μεταβολών και των ημερήσιων διακυμάνσεων στον υγροβιότοπο.

Τα στάδια προσέγγισης των καταγραφών ορίστηκαν ως εξής: α) *Ανίχνευση*: Σε μία ή και παραπάνω αναγνωριστικές επισκέψεις στη περιοχή, η ομάδα περιηγήθηκε σε πιθανά σημεία ενδιαφέροντος, στα οποία πραγματοποίησε δοκιμές, ώστε να εκτιμήσει και να αξιολογήσει το πιθανό ηχητικό και οπτικό υλικό προς καταγραφή, καθώς και να εξοικειωθεί με τον εξοπλισμό σε συνθήκες πεδίου. β) *Καταγραφή*: Πραγματοποιήθηκαν καταγραφές στα επιλεγμένα σημεία με ειδικό εξοπλισμό, εφαρμόζοντας τεχνική ηχογράφησης συμβατή με ηχογραφήσεις πεδίου (field recording), με ταυτόχρονη καταγραφή οπτικού υλικού (κινηματογραφήσεις). γ) *Αποθήκευση/αρχαιοθέτηση*: Το πρωτογενές καταγεγραμμένο υλικό αρχειοθετήθηκε με τρόπο ώστε να είναι εύκολα προσβάσιμο. δ) *Επεξεργασία*: Το πρωτογενές υλικό επεξεργάστηκε ώστε να είναι σε μορφή (format) κατάλληλη για ακρόαση και θέαση. ε) *Ανάλυση/Αξιολόγηση*: Το επεξεργασμένο υλικό αναλύθηκε ως προς τους ήχους που παρατηρήθηκαν στα σημεία, ανά εποχή, (ηχητικές πηγές, ηχητικό ενδιαφέρον, επικρατέστεροι ήχοι), και κατατάχθηκε αναλόγως σε πίνακα (Σχήματα 4.1, 4.2).



Σχήμα 2. Τα 7 σημεία καταγραφών



Σχήμα 3. Χρονοδιάγραμμα Καταγραφών (για ένα σημείο)

⁹⁹ Οι συντεταγμένες των σημείων: Σημείο Α: 37.92724,2, 24.003187, Σημείο Β: 37.926630, 24.002005, Σημείο Γ: 37.925092, 24.000265 Σημείο Δ: 37.924657, 24.000481, Σημείο Ε: 37.924955, 23.994754, Σημείο ΣΤ: 37.925447, 23.994373, Σημείο Ζ: 37.926767, 23.995168.

¹⁰⁰ Στα πλαίσια της έρευνας ορίζεται ως *Ετήσιος Κύκλος* η περίοδος Μάιος-Δεκέμβριος του 2019.

¹⁰¹ Για την κάθε εποχή επιλέχθηκε ένας χαρακτηριστικός από καιρικές συνθήκες μήνας για πραγματοποίηση των καταγραφών. Συγκεκριμένα, Μάιος, Ιούλιος, Σεπτέμβριος, Δεκέμβριος.

¹⁰² Στα πλαίσια της εργασίας ορίζεται ως *Ημερήσιος Κύκλος* το ένα εικοσιτετράωρο.

	Πολύ ενδιαφέρουσα ηχητική καταγραφή	
	Ηχητική καταγραφή με ικανοποιητικό ενδιαφέρον	
	Ηχητική καταγραφή με μέτριο ενδιαφέρον	
	Ηχητική καταγραφή με ελάχιστο ενδιαφέρον	
λλ:δδ	Χρονικό σημείο στην καταγραφή όπου ακούγονται ηχητικά δείγματα.	

Σχήμα 4.1. Υπόμνημα Πίνακα Αξιολόγησης

ΚΥΡΙΑΚΗ 14 ΔΕΚΕΜΒΡΙΟΥ 2019									
Αριθμός Αρχειο	Όνομα Αρχειο	Διάρκεια	Σημείο	Ώρα	Σημείο επισημασμένο	Γενικές Παρατηρήσεις	Αξιολόγηση	Παρατηρήσεις	
191214-0955	A1_X_1	11:01	A	7:40	1:00, 1:40, 2:08, 3:43, 6:10, 9:40	Αυτοκίνητα Αρσενάκι		Οριζίας, Νηρό	
191214-0956	A2_X_1	11:04	B	7:50	0:30, 1:10, 1:51, 5:21, 6:52, 9:50, 10:16	Αυτοκίνητα Αρσενάκι		Οριζίας, Νηρό, Καμίνια	
191214-0957	A3_X_1	12:00	Γ	8:15	0:18, 1:50, 3:47, 8:25, 11:49	Αυτοκίνητα Αρσενάκι		Νηρό, Καμίνια	
191214-0958	A4_X_1	16:47	Δ	9:00	0:40, 3:29, 6:32, 7:47, 8:57, 10:04, 10:37	Αυτοκίνητα Αρσενάκι		Χλωροκαπνός	
191214-0959	A5_X_1	12:07	Ε	9:30	0:7, 0:11, 0:46, 1:12, 1:34, 6:08, 8:45, 10:09, 11:16	Αυτοκίνητα Αρσενάκι		Χλωροκαπνός, Πρόβατα, Άλφας	
191214-0960	A6_X_1	8:41	ΣΤ	9:50	0:25, 0:35, 3:00, 3:24, 4:57, 5:54	Αυτοκίνητα Αρσενάκι			
191214-0962	A7_X_1	9:33	Z	10:23	0:44, 3:49, 4:15, 5:11, 5:31, 7:54	Αυτοκίνητα Αρσενάκι			
191214-0964	A1_X_2	11:40	A	13:25	0:52, 7:15, 8:32, 9:25	Αυτοκίνητα Αρσενάκι		Οριζίας	
191214-0965	A2_X_2	10:44	B	13:50	2:12, 3:02, 3:50, 6:22, 9:21, 10:18	Αυτοκίνητα Αρσενάκι		Οριζίας	
191214-0967	A3_X_2	12:01	Γ	14:22	7:49	Αυτοκίνητα Αρσενάκι		Νηρό	
191214-0968	A4_X_2	10:12	Δ	14:40	1:12, 3:12, 4:21, 6:30, 8:19	Αυτοκίνητα Αρσενάκι		Οριζίας	
191214-0970	A5_X_2	11:13	Ε	15:10	0:1, 1:26, 2:25, 3:13, 5:56, 6:25, 11:04	Αυτοκίνητα Αρσενάκι		Βίγες	
191214-0972	A6_X_2	11:43	ΣΤ	15:30	1:20, 3:18, 3:44, 6:50, 7:49	Αυτοκίνητα Αρσενάκι			
191214-0973	A7_X_2	10:06	Z	15:45	1:34, 3:42, 4:15, 5:07, 6:43	Αυτοκίνητα Αρσενάκι			
191214-0974	A1_X_3	19:28	A	17:50	4:25	Αυτοκίνητα Αρσενάκι			
191214-0975	A2_X_3	10:03	B	18:05	1:07	Αυτοκίνητα Αρσενάκι			
191214-0976	A3_X_3	11:59	Γ	18:35	7:17	Αυτοκίνητα Αρσενάκι		Νηρό	
191214-0977	A4_X_3	10:50	Δ	18:50	0:56	Αυτοκίνητα Αρσενάκι			
191214-0978	A5_X_3	9:43	Ε	19:25	4:21, 7:00	Αυτοκίνητα Αρσενάκι		Οριζίας	
191214-0979	A6_X_3	10:05	ΣΤ	19:45	3:27, 6:19, 9:32, 9:57	Αυτοκίνητα Αρσενάκι			
191214-0980	A7_X_3	11:25	Z	20:05	-	Αυτοκίνητα Αρσενάκι		Νηρό	

Σχήμα 4.2. Απόσπασμα του Πίνακα Αξιολόγησης

4. Επιλογή Σημείων Καταγραφής

Τα σημεία A και B βρίσκονται στην παράκτια περιοχή του υγροβιότοπου. Το σημείο Γ βρίσκεται σε ένα μικρό ξέφωτο, κοντά σε μία από τις εισόδους του υγροβιότοπου, δίπλα από έναν μικρό παραπόταμο του Ερασίνου. Το σημείο Δ, πάνω σε ένα ύψωμα, εποπτεύει το Δέλτα του Ερασίνου. Το σημείο Ε είναι στο μονοπάτι περιήγησης που διαθέτει η περιοχή. Το σημείο ΣΤ είναι απέναντι από τον αρχαιολογικό χώρο και δίπλα από το βάλτο. Τέλος, το σημείο Ζ είναι σε ένα ξέφωτο, δίπλα από το βάλτο. Επειδή η περιοχή είναι προστατευόμενη και η πρόσβαση είναι μερικώς περιορισμένη, τα εγκεκριμένα για επισκέπτες μονοπάτια και σημεία θέασης, τα οποία προτείνει η Ορνιθολογική Εταιρεία -με σχετικές πινακίδες στην περιοχή-, είναι τα A-B, Γ-Δ, Γ-Ζ, Γ-Ε, Ε-ΣΤ, και ΣΤ-Ζ (Βλ. Σχήμα 2).

Σημείο A: Βρίσκεται στην ακτή κοντά στο πρώτο κύριο στοιχείο του υγροβιότοπου, τη θάλασσα, και προσφέρεται για συλλογή ήχων όπως φωνήματα πτηνών και ήχους περιβάλλοντος (αέρας, κυματισμός θάλασσας κ.ά.). Η κοντινή οικιστική περιοχή, το εστιατόριο, ο αυτοκινητόδρομος και το αεροδρόμιο, αποτελούσαν πηγές ανθρωπογενών ήχων, συχνά ανεπιθύμητες.

Σημείο B: Το σημείο αυτό επιλέχθηκε λόγω της εγγύτητάς του στα σημεία όπου φωλιάζουν τα πουλιά, στο κέντρο του υγροβιότοπου, σε μικρή απόσταση από την ακτή. Επιλέγοντας το σημείο αυτό, στόχος ήταν μια ποιοτικότερη καταγραφή της παράκτιας περιοχής του υγροβιότοπου, με περισσότερους βιολογικούς (μη-ανθρώπινους), παρά ανθρωπογενείς ήχους.

Σημείο Γ: Η επιλογή του σημείου έγινε με βάση την εγγύτητά του σε ένα από τα κυριότερα υγρά στοιχεία του υγροβιότοπου, το ρυάκι από τον ποταμό Ερασίνο. Εκτιμήθηκε ότι λόγω της πυκνής βλάστησης, η παρουσία της πανίδας θα ήταν έντονη και συνεχής. Επειδή το σημείο ήταν κοντά σε έναν ήσυχο χωματόδρομο, θεωρήθηκε πως οι ανεπιθύμητοι ήχοι από τα αυτοκίνητα και από τους επισκέπτες θα ήταν περιορισμένοι.

Σημείο Δ: Υπερυψωμένο σημείο με ιδιαίτερο αισθητικό ενδιαφέρον παρέχει μια πανοραμική οπτική του υγροβιότοπου. Λόγω της έντονης βλάστησης και του ελαφρώς αυξημένου υψόμετρου του, θεωρήθηκε πως καταγραφές από το συγκεκριμένο σημείο θα αποδώσουν ικανοποιητικά τους ήχους από την ορνιθοπανίδα και θα προσφέρει μια ευρύτερη οπτική και ηχητική «απεικόνιση» του υγροβιότοπου.

Σημείο Ε: Σημείο με έντονη βλάστηση, ψηλά δέντρα, κυκλωμένο από καλλιεργήσιμες εκτάσεις με αμπέλια και ελιές. Επιλέχθηκε λόγω του μονοπατιού περιήγησης το οποίο ενδείκνυται για παρατήρηση πουλιών, αποσκοπώντας στη συλλογή διαφορετικών φωνημάτων πουλιών.

Σημείο ΣΤ: Τοποθετημένο στον ειδικά διαμορφωμένο σταθμό παρατήρησης, δίπλα από το μονοπάτι περιήγησης και κοντά στον αρχαιολογικό χώρο. Σημείο που ενδείκνυται για παρατήρηση χλωρίδας και πανίδας, και ειδικότερα πτηνών, αμφιβίων και εντόμων.

Σημείο Ζ: Παρότι ο αυτοκινητόδρομος κοντά προμήνυε την έντονη παρουσία μηχανικών ήχων/θορύβων από οχήματα, το σημείο αυτό επιλέχθηκε καθώς αποτελεί ένα ακόμα ειδικά διαμορφωμένο μέρος παρατήρησης χλωρίδας και πανίδας, πολύ κοντά στο τρίτο υγρό στοιχείο της περιοχής, το έλος.

5. Καταγραφές

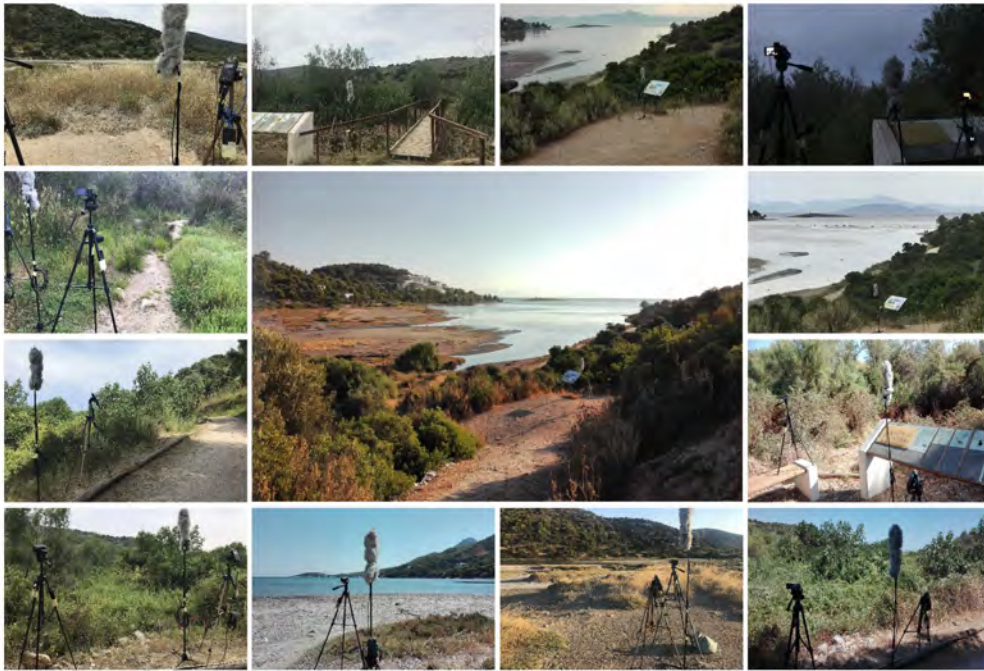
Οι ηχογραφήσεις αποσκοπούσαν στην αυθεντική αναπαράσταση του περιβάλλοντος και στην αποτύπωση της χωρικής και χρονικής μεταβολής του ηχοτοπίου. Για τη διεξαγωγή τους χρησιμοποιήθηκε η συμπτωτική στερεοφωνική τεχνική ηχογράφησης πεδίου M/S (Mid/Side). Οι κινηματογραφήσεις συμπλήρωναν τα ακουστικά δεδομένα παρέχοντας οπτικό πλαίσιο, σημεία αναφοράς αλλά και δεδομένα σχετικά με την τοποθεσία, τις καιρικές συνθήκες και τη χρονική στιγμή της καταγραφής. Επιπλέον, παρείχαν πληροφορίες για διάφορα απρόοπτα συμβάντα εν ώρα καταγραφής (π.χ. περιπατητές σε κοντινή απόσταση).

Η συγκεκριμένη έρευνα εξετάζει επίσης τις αλλαγές/διαφοροποιήσεις στο ηχοτόπιο με βάση τις εποχιακές και ημερήσιες μεταβολές. Για αυτό το λόγο δημιουργήθηκε μια βάση δεδομένων με ποιοτικά και ποσοτικά στοιχεία, κατηγοριοποιημένα ανά τοποθεσία, ημέρα και ώρα, συνοδευόμενη από μια αρχική υποκειμενική αξιολόγηση του ηχητικού ενδιαφέροντος των ηχογραφήσεων ως προς την ηχοποικιλότητα και την βιοποικιλότητα (βλ. Σχήμα 4.2). Επιπλέον, η έρευνα παρουσιάζει αρχεία ήχου σε αποκωδικοποιημένη στερεοφωνική μορφή που προβάλλουν τους χαρακτηριστικούς ήχους του υγροβιότοπου, συνοδευόμενα από μια συλλογή στατικών κινηματογραφήσεων.

Για τις ηχογραφήσεις και βιντεοσκοπήσεις που πραγματοποιήθηκαν στον υγροβιότοπο της Βραυρώνας, επιλέχθηκε η μέθοδος της παθητικής καταγραφής, η οποία συνίσταται στην όσο το δυνατόν πιο διακριτική παρουσία των μελών της ερευνητικής ομάδας κατά τη διάρκεια των καταγραφών, με σκοπό την ελαχιστοποίηση της παρέμβασης στο ηχητικό και οπτικό πεδίο (Λουφόπουλος, Εμμανουήλ, Μαραγκός, & Κατερέλος, 2012). Σε κάθε καταγραφή ο εξοπλισμός τοποθετούνταν στην ίδια ακριβώς θέση, χρησιμοποιώντας ως σημεία αναφοράς φωτογραφίες από την πρωταρχική τοποθέτηση και φυσικά σημάδια στο χώρο των καταγραφών. Στόχος ήταν να δημιουργηθούν παρόμοιες συνθήκες καταγραφής για την αποτελεσματική σύγκριση των εγγραφών μεταξύ τους, διασφαλίζοντας ότι τυχόν διαφοροποιήσεις που παρατηρήθηκαν οφείλονταν στο ίδιο το περιεχόμενο και όχι σε διαφορές στις ρυθμίσεις και στην τοποθέτηση του εξοπλισμού. Κάθε καταγραφή είχε διάρκεια περίπου δεκαπέντε λεπτών, με σκοπό να εξαχθεί ωφέλιμο υλικό διάρκειας τουλάχιστον δέκα λεπτών.

5.1. Ηχογραφήσεις

Για την πιστότερη ηχητική απεικόνιση και λαμβάνοντας υπόψη τις ιδιαιτερότητες και τις συνθήκες που ενέχει η ηχογράφηση στο πεδίο (field recording) επιλέχθηκε η συμπτωτική τεχνική ηχογράφησης M/S (Mid/Side) λόγω της ανάγκης για στερεοφωνική καταγραφή του ηχοτοπίου. Η τεχνική αυτή είναι ευρέως αποδεκτή για ηχογραφήσεις φυσικών τοπίων, λόγω της σαφήνειας και της ευελιξίας που παρέχει κατά την επεξεργασία όσον αφορά στη διαμόρφωση του εύρους και του βάθους (Huber & Runstein, 2017, σ. 141.). Πλεονέκτημα αυτής της τεχνικής αποτελεί το μικρό βάρος του εξοπλισμού που χρειάζεται για την πραγματοποίησή της στο πεδίο. Χρησιμοποιήθηκε το μικρόφωνο Studio Projects LSD2 το οποίο διαθέτει δύο μεγάλου διαφράγματος κάψες. Για την επάνω κάψα επιλέχθηκε το παντο-κατευθυντικό (omni directional) διάγραμμα και για την κάτω επιλέχθηκε το δι-κατευθυντικό διάγραμμα (figure of 8). Η επάνω κάψα του μικροφώνου τοποθετήθηκε ώστε να στοχεύει (on-axis) με το νοητό κέντρο του υγροβιότοπου σε όλα τα σημεία και όλες τις καταγραφές. Η κάτω κάψα τέθηκε σε γωνία 90 μοιρών off-axis σε σχέση με την επάνω, δηλ. κάθετα ως προς το νοητό κέντρο του υγροβιότοπου, λαμβάνοντας πληροφορίες του περιφερειακού χώρου (Σχήμα 5). Για να αποφευχθούν ανακλάσεις και να αποδοθεί ρεαλιστικά ο ήχος, το μικρόφωνο τοποθετήθηκε σε ύψος 1.7 μέτρων, προσεγγίζοντας το ύψος των αυτιών του μέσου ανθρώπου, και εφαρμόστηκε σε αυτό αφρώδες αντιανεμικό και αντιανεμικό τύπου γούνας. Για την εγγραφή ήχου χρησιμοποιήθηκε ο φορητός εγγραφέας Tascam DR-40 σε ανάλυση 24 bit και συχνότητα δειγματοληψίας 96 kHz για βέλτιστη ποιότητα ήχου.



Σχήμα 5. Ο καταγραφικός εξοπλισμός στα σημεία καταγραφής

5.2. Κινηματογραφήσεις

Η κινηματογράφηση πραγματοποιήθηκε για αρχαιακούς λόγους με βασικό στόχο την αποτύπωση των συνθηκών υπό τις οποίες έγιναν οι καταγραφές, τη συλλογή επιπλέον πληροφοριών για το περιβάλλον, καθώς και τη χρήση τους ως αναφορά, κατά την εύρεση των σημείων εγγραφής. Οι κινηματογραφήσεις δεν αποσκοπούσαν μόνο στη συνοδεία του ηχητικού υλικού, αλλά επιπλέον στην παροχή ενός πρόσθετου επιπέδου άντλησης δεδομένων, με στόχο την επιπλέον αποτίμηση και εκτίμηση των ηχητικών καταγραφών. Για τη στατική κινηματογράφηση χρησιμοποιήθηκε η κάμερα SONY HDR cx320 με δυνατότητα καταγραφής υψηλής ευκρίνειας (HD) και βάση ελαφρώς τύπου τριών σκελών. Σε κάθε καταγραφή η κάμερα ήταν τοποθετημένη έτσι ώστε ο φακός της να στοχεύει στο νοητό κέντρο του υδροβιότοπου.

5.3. Επεξεργασία του Υλικού

Το πρωτογενές ηχητικό και οπτικό υλικό που κατέγραψε η ομάδα στο πεδίο υπέστη μόνο την απαραίτητη (ελάχιστη) επεξεργασία ώστε να διευκολύνει την μετέπειτα αξιολόγηση του υλικού. Η επεξεργασία ξεκίνησε αποκωδικοποιώντας τις ηχογραφήσεις σε πρόγραμμα ψηφιακής επεξεργασίας ήχου. Το ηχητικό αρχείο διαχωρίστηκε σε δύο κανάλια, το Mid και το Side και δημιουργήθηκε ένα νέο -τρίτο- κανάλι, αντίγραφο του Side καναλιού, με ανεστραμμένη πολικότητα. Το Mid κανάλι τοποθετήθηκε στο κέντρο του στερεοφωνικού πανοράματος, και τα δύο Side κανάλια στα δύο άκρα του, αριστερά ("hard left") και δεξιά ("hard right"). Κατά τη διαδικασία της μίξης τα δύο Side κανάλια ορίστηκαν στα -3dB σε σχέση με το Mid, όπως απαιτείται για τη σωστή αναπαραγωγή της καταγεγραμμένης στερεοφωνικής εικόνας. Πραγματοποιήθηκε ήπια αποθρομβοποίηση χρησιμοποιώντας τον αλγόριθμο Z-Noise της εταιρείας Waves, με ρυθμίσεις προσαρμοσμένες στην εκάστοτε ηχογράφιση. Μειώθηκαν συχνότητες κάτω των 80 Hz χρησιμοποιώντας το υπερπυκνό φίλτρο Simplon της εταιρείας FabFilter. Αφαιρέθηκαν -σε λίγες ηχογραφήσεις- οι θόρυβοι τύπου "pops" προερχόμενοι κυρίως από το καλώδιο του μικροφώνου χρησιμοποιώντας τον αλγόριθμο αποκατάστασης X-Crackle της εταιρείας Waves. Στόχος των επεξεργασιών ήταν η διασφάλιση της ποιότητας του ηχητικού υλικού και ταυτόχρονα η αποφυγή οποιασδήποτε αλλοίωσης στο τελικό ηχητικό αποτέλεσμα. Τα τελικά stereo αρχεία ήχου εξήχθησαν σε μορφή *.wav, με 96 kHz δειγματοληψίας και ανάλυσης 24 bit.

Οι κινηματογραφήσεις υπέστησαν ελάχιστη επεξεργασία, εστιάζοντας κυρίως στη χρωματική διόρθωση των πλάνων και στην προσθήκη επεξηγηματικού κειμένου και τίτλων. Χρησιμοποιήθηκαν τα βασικά εργαλεία cut, cross-effect transition, text και colour του προγράμματος επεξεργασίας εικόνας και κινηματογραφήσεων Vegas, της εταιρείας MAGIX.

5.4. Ανάλυση του Υλικού

Από το σύνολο των επεξεργασμένων ηχογραφήσεων επιλέχθηκαν χρονικά σημεία ενδιαφέροντος και απομονώθηκαν τριάντα επτά δείγματα με φωνήματα πουλιών και ήχους από ζώα που ζουν στον υγροβιότοπο. Από αυτά τα δείγματα, τα δεκαπέντε χρησιμοποιήθηκαν για την ταυτοποίηση διαφορετικών πτηνών και ζώων με την πολύτιμη συνεισφορά της διαδικτυακής ομάδας «Birding In Athens»¹⁰³.

Κάθε μία από τις ογδόντα τέσσερις καταγραφές αξιολογήθηκε υποκειμενικά με βάση το συνολικό ηχητικό ενδιαφέρον της, μετά από ποιοτική ανάλυση του περιεχομένου των δεκάλεπτων ηχογραφήσεων. Η αξιολόγηση έγινε με ακρόαση των ηχογραφήσεων και αξιοποίηση των σημειώσεων που κράτησε η ομάδα στο πεδίο, καθώς και των κινηματογραφήσεων που είχαν γίνει. Δημιουργήθηκε ένας πίνακας με ποσοτικά και ποιοτικά δεδομένα για την καλύτερη περιγραφή και κατανόηση του ηχητικού περιεχομένου του ηχοτοπίου, με σκοπό να παρέχει πληροφορίες καθώς και τα χρονικά σημεία στις ηχογραφήσεις με έντονο ηχητικό ενδιαφέρον (Βλ. Σχήμα 4.2). Ηχογραφήσεις με πλούσια ηχοποικιλότητα και χαμηλό επίπεδο θορύβου χαρακτηρίστηκαν ως αυτές με το μεγαλύτερο ενδιαφέρον. Ως λιγότερο ενδιαφέρουσες ηχογραφήσεις χαρακτηρίστηκαν αυτές με λιγότερη ηχοποικιλότητα και υψηλότερο επίπεδο θορύβου σε σχέση με τους (επιθυμητούς) ήχους του περιβάλλοντος, με βάση τον ορισμό ενός Hi-Fi Ηχοτοπίου¹⁰⁴. Χρησιμοποιήθηκε χρωματικός κώδικας, όπως φαίνεται στο υπόμνημα του πίνακα (Βλ. Σχήμα 4.1), έτσι ώστε να γίνεται εύκολα αντιληπτή η κατηγορία στην οποία έχει καταταχθεί η κάθε καταγραφή.

Η ανάλυση, η κατηγοριοποίηση και η αξιολόγηση¹⁰⁵ των ήχων του περιβάλλοντος δεν έγινε στο πεδίο, αλλά σε μετέπειτα στάδιο, συγκεκριμένα κατά τη διάρκεια ακρόασης των ηχογραφήσεων με γνώμονα την προέλευσή τους. Κατηγοριοποιήθηκαν σε βιολογικούς (μη-ανθρώπινους) ήχους, ανθρωπογενείς ήχους (βιολογικούς και μηχανικούς ήχους), γεωφυσικούς ήχους (Ετμεκτσόγλου, 2013). Επίσης, μερικοί ήχοι χαρακτηρίστηκαν ως «θόρυβοι», σύμφωνα με την προσέγγιση του Schafer περί θορύβου, που θεωρείται ως ενόχληση μιας ηχογόνας πηγής, μηχανικής ή ηλεκτρονικής, που παράγει μεγάλης ισχύος ήχους (Μνιέστρης, 2018).

Σημείο Α: Οι ήχοι που συλλέχθηκαν στην πλειοψηφία τους ήταν ανθρωπογενείς και θόρυβοι (αυτοκίνητα, αεροπλάνα, ομιλίες), ενώ καταγράφηκαν επίσης βιολογικοί ήχοι από ζώα (φωνήματα πουλιών, π.χ. λάλημα κόκορα), καθώς και γεωφυσικοί ήχοι (κυματισμός της θάλασσας, θρόισμα των φύλλων λόγω του αέρα).

Σημείο Β: Οι ήχοι που συλλέχθηκαν από αυτό το σημείο ήταν κυρίως ανθρωπογενείς (ομιλίες, μουσική από το ξενοδοχείο, ήχος καμπάνας, αυτοκίνητα, αεροπλάνα). Λιγότεροι ήταν οι βιολογικοί (μη-ανθρώπινοι) και γεωφυσικοί ήχοι (κυματισμός της θάλασσας).

Σημείο Γ: Καταγράφηκαν γεωφυσικοί ήχοι από το ρυάκι, βιολογικοί ήχοι από τα πουλιά και τα έντομα, ήχοι από τις κουδούνες των προβάτων και μηχανικοί ήχοι όπως το χτύπημα μιας καμπάνας. Επιπλέον, καταγράφηκαν ανθρωπογενείς ήχοι από ομιλίες και αναπαραγωγή μουσικής από το γειτονικό ξενοδοχείο, θόρυβοι από τις διελεύσεις των αεροπλάνων και από την κίνηση οχημάτων στη λεωφόρο.

Σημείο Δ: Οι ήχοι που παρατηρήθηκαν και καταγράφηκαν ήταν ανθρωπογενείς και βιολογικοί (μη-ανθρώπινοι) όπως η θάλασσα, ο αέρας, πουλιά, πρόβατα και κουδούνες, ομιλίες από περαστικούς, αλλά και θόρυβοι όπως ο περιπλανώμενος πωλητής και η μουσική από το ξενοδοχείο.

Σημείο Ε: Οι ήχοι που παρατηρήθηκαν ήταν κυρίως γεωφυσικοί και βιολογικοί μη-ανθρώπινοι, όπως θρόισμα των φύλλων, φωνήματα πουλιών, ήχοι από το νερό, από πρόβατα κ.ά., ανθρωπογενείς ήχοι, όπως βήματα, ομιλίες περαστικών, θόρυβος από διελεύσεις οχημάτων και πτήσεις αεροπλάνων και ο μηχανικός ήχος από καμπάνα.

¹⁰³ Αναφέρονται ενδεικτικά: Καλόγερος, Νερόκοτα, Μαυροτσιροβάκος, Ψευταηδόνι, Ωχροστριτίσιδα, Καρακάξα, Βαλκανικός Βαλτοβάτραχος, Μαυρολαίμης, Δεντροβάτραχος, Αλκυόνη, Κίσσα, Σταχτοτσικνιάς, Υφάντρα, Σπίνος, Κοκκινολαίμης, Νεροκοτσέλα, Σιρλοτσιχλονο.

¹⁰⁴ Ο χαρακτηρισμός «ηχοτοπίο υψηλής πιστότητας» κατά τον Schafer, αποδίδεται σε ηχοτοπία με μεγάλο λόγο σήματος ως προς (περιβαλλοντικό) θόρυβο (Signal to Noise Ratio - SNR). Τα συγκεκριμένα ηχοτοπία έχουν ιδιαίτερη ακουστική διαφάνεια και οι ήχοι τους δεν αλληλοεπικαλύπτονται. Ο Schafer «δανείζεται» την έννοια από τα υψηλής πιστότητας (High Fidelity) ηχοσυστήματα που αναπαράγουν με εξαιρετική πιστότητα, ευκρίνεια και υψηλό SNR τον ηχογραφημένο ήχο. Ο Schafer υποστηρίζει πως τα ηχοτοπία της φύσης, κυρίως, αποτελούν ηχοτοπία υψηλής πιστότητας (Schafer, 1994, σ. 272).

¹⁰⁵ Η πλήρης ανάλυση και ο πίνακας αξιολόγησης έχουν αναρτηθεί στον παρακάτω σύνδεσμο:
https://drive.google.com/drive/folders/1T6iVnGE8U9KChqbY5hPn-aoR0vL-na3t?usp=drive_link

Σημείο ΣΤ: Οι ήχοι που παρατηρήθηκαν ήταν γεωφυσικοί όπως το θρόισμα των φύλλων, βιολογικοί ήχοι από πουλιά, έντομα, βιολογικοί ήχοι από τους βάτραχους στο έλος, μηχανικοί ήχοι από κουδούνες προβάτων, καθώς και θόρυβος από πτήσεις αεροπλάνων.

Σημείο Ζ: Παρατηρήθηκαν μηχανικοί ήχοι/θόρυβοι από χλοοκοπτικό, αυτοκίνητα, δίκυκλα, αεροπλάνα και μουσική προερχόμενη από το γειτονικό ξενοδοχείο, και βιολογικοί ήχοι όπως τα κρωξίματα από βατράχια, ιδιαίτερα έντονα μόνο στην ανοιξιάτικη ηχογράφηση, όπως και ήχος από τα έντομα (κουνούπια, σκνίπες).

Το τελικό υλικό αξιοποιήθηκε για τη δημιουργία μιας συλλογής από ήχους των φωνημάτων των πουλιών που αναγνωρίστηκαν, καθώς και επτά συρραφές αποσπασμάτων συγχρονισμένων ήχων και κινηματογραφήσεων που καλύπτουν το σύνολο των σημείων συμπεριλαμβάνοντας στιγμιότυπα από όλες τις εποχές και ώρες για την ανάδειξη των χρονικών μεταβολών του ηχοτοπίου στον υγροβιότοπο¹⁰⁶.

6. Συμπεράσματα - Παρατηρήσεις

Συμπερασματικά, ο υγροβιότοπος της Βραυρώνας αποτελεί ένα Υψηλής Πιστότητας (Hi-Fi) Ηχοτοπίο (Schafer, 1994, σ. 272), με υψηλή ακουστική και αισθητική ποιότητα. Παρατηρείται μεγάλη πυκνότητα ηχητικών δεδομένων και ηχητική ποικιλομορφία (ηχοποικιλότητα) κυρίως λόγω της μεγάλης συγκέντρωσης ορνιθοπανίδας στα σημεία καταγραφής.

Το ηχοτοπίο στο σύνολο των σημείων κρίνεται ως ετερογενές καθώς συγκροτείται από στοιχεία της φύσης αλλά και από ανθρωπογενείς δραστηριότητες. Οι ηχογόνες πηγές διαφοροποιούνται ανά εποχή. Δεν παρατηρείται έντονα το φαινόμενο της ηχητικής σκίασης¹⁰⁷ (masking), με τους ήχους να συνυπάρχουν αρμονικά μεταξύ τους, συντελώντας στην υψηλή πιστότητα του ηχοτοπίου. Παρά τους θορύβους, οι γεωφυσικοί και βιολογικοί (μη-ανθρώπινοι) ήχοι παραμένουν ευδιάκριτοι.

Γενική παρατήρηση για το σύνολο των εποχών και σημείων καταγραφής, είναι πως οι πρωινές ηχογραφήσεις, παρουσιάζουν χαμηλή πυκνότητα ηχητικών πληροφοριών και μικρό δυναμικό εύρος. Ο ακουστικός ορίζοντας¹⁰⁸ είναι μεγάλος, επιτρέποντας την ανίχνευση μακρινών ήχων. Οι μεσημεριανές ηχογραφήσεις διαφοροποιούνται ανά εποχή, για παράδειγμα, το καλοκαίρι και φθινόπωρο κυριαρχούν τα συνεχόμενα φωνήματα των τζίτζικων, ενώ τον χειμώνα και την άνοιξη απουσιάζουν. Σε όλες τις εποχές οι απογευματινές ηχογραφήσεις είναι κατά βάση πιο ήσυχες από τις μεσημεριανές, με χαμηλότερη ένταση της οδικής κυκλοφορίας και την μεγαλύτερη κυριαρχία του γεωφυσικού ήχου του ανέμου.

Το περιβάλλον εμφάνιζε χαρακτηριστικά εγκατάλειψης και ανεπαρκούς συντήρησης. Παρατηρήθηκε πυκνή αυτοφυής βλάστηση και θραύσματα ξύλων και κλαδιών στις όχθες, μέσα στο έλος και στο ρυάκι. Παρατηρήθηκαν απορρίμματα εκτός των κάδων σε σωρούς, όπως και διάσπαρτα απορρίμματα στην περιοχή γενικότερα. Οι ενημερωτικές πινακίδες είχαν υποστεί φθορά και οι διαδραστικές πινακίδες στα παρατηρητήρια της Ορνιθολογικής Εταιρείας δεν αναπαρήγαγαν τους ήχους. Τέλος, η πραγματοποιηθείσα έρευνα μπορεί να χρησιμοποιηθεί και για εκπαιδευτικούς/περιβαλλοντικούς σκοπούς (Λουφόπουλος, Εμμανουήλ, Μαραγκός, & Κατερέλος, 2012), υπογραμμίζοντας την ανάγκη για την προστασία και διατήρησή του.

Το υλικό που καταγράφηκε στο πλαίσιο της συγκεκριμένης έρευνας δύναται να διατεθεί, κατόπιν αιτήματος, σε φορείς και συλλόγους που προασπίζονται τη διατήρηση και αξιοποίηση του υγροβιότοπου, με τους οποίους η ομάδα καταγραφής έχει ήδη έρθει σε επαφή. Οι καταγραφές από το έτος 2019 ενδέχεται να αποτελούν ένα από τα ελάχιστα οπτικοακουστικά τεκμήρια της σημασίας του υγροβιότοπου, προσφέροντας περαιτέρω αποδεικτικά στοιχεία για την αναγκαιότητα της προστασίας του. Ευχή όλων αποτελεί το γεγονός αυτές οι καταγραφές να μην αποτυπώνουν ηχοτοπία που θα χαθούν στο πέρασμα του χρόνου, καθιστώντας τα τεκμήρια ενός εξαφανισμένου παρελθόντος.

¹⁰⁶ Η συλλογή με τα φωνήματα των πουλιών που αναγνωρίστηκαν, καθώς και οι καταγραφές για τα σημεία Α και Δ που παρουσίαζαν το μεγαλύτερο ηχητικό και οπτικό ενδιαφέρον, έχει αναρτηθεί σε λίστα αναπαραγωγής στην εξής διεύθυνση: <https://www.youtube.com/watch?v=WK7gGyytDB8&list=PLxPo5fSOvr587Ws89eOf2g1jEYMYUYxhM>

¹⁰⁷ Το φαινόμενο της «ηχητικής σκίασης» (masking) σχετίζεται με τη δυσκολία διάκρισης ήχων σε ένα ηχοτοπίο. Σε ένα υψηλής πιστότητας περιβάλλον, οι διαφορετικοί ήχοι διατηρούνται ευδιάκριτοι, εκτός αν άλλοι ήχοι παρόμοιου φάσματος τους επικαλύπτουν (Schafer, 1994: 43).

¹⁰⁸ Ακουστικός Ορίζοντας σύμφωνα με τον Truax είναι η πιο μακρινή απόσταση σε κάθε κατεύθυνση από την οποία ήχοι μπορούν να γίνουν ακουστοί (Truax, 1999).

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The Wetland of Vravrona: Case study of a Recording of a Threatened Soundscape

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Abstract

The wetland of Vravrona, located between the urbanized Artemis and the rapidly developing Markopoulo, stands as a vital wildlife habitat in Attica. Remarkably, its landscape has remained almost unchanged since ancient times. However, contemporary environmental concerns loom large: the ongoing conversion of Erasinos River's natural banks into engineered structures threatens the rich biodiversity that defines this significant region.

The present study concerns the recording and analysis of the characteristics of the wetland of Vravrona and was conducted in 2019, prior to the works and interventions in the wetland. The primary objective of this research was the acquisition of different types of data (recordings, film, and photographs). Our focus centered on studying spatio-temporal variations of sound in this unique ecosystem. Moreover, in order to represent the wetland and its changes throughout an annual cycle (from May to December 2019) more accurately, we conducted four recordings (one for each season for three different time periods (morning, midday and afternoon-dusk)).

The soundscape of the Vravrona wetland is characterized as a high-fidelity (Hi-Fi) environment, distinguished by exceptional acoustic and aesthetic sound quality. There is a high density of sound data and sound diversity due to a high concentration of avifauna at the recording positions.

Keywords

Wetland, Soundscape, Field recording, Spatio-temporal recording, Vravrona

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