Mapping Soundscapes of Warning

Experimental Interfaces for Public Sound Culture

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Abstract

This short paper introduces *Soundscapes of Warning*, an experimental research application designed to support the comparative study of public warning signals as cultural and aesthetic artefacts. Developed through a collaboration between Linköping University and C²DH at the University of Luxembourg, the platform enables users to explore how alarm sounds, sirens and civil alert signals, vary across national and historical contexts. By combining geographic comparison with custom-designed 3D visualizations of alarm signals, the application offers a new model for investigating how warnings and urgency have been rendered sonically in different societies. Instead of approaching warning sounds as purely functional or technical signals, the platform emphasizes their role in shaping public space and the semiotics of danger. Designed as both a research tool and an interpretive interface, *Soundscapes of Warning* contributes to current efforts in the digital humanities to critically engage with sound as a mediated and historically contingent form.

Keywords

digital humanities, research infrastructure, warning signals, sound studies

1. Introduction

At the instant a warning signal echoes across its surroundings, it carries something both unsettling and familiar. Designed to announce disruption, the alarm also resonates like a natural phenomenon: ubiquitous and habitual. Over time, these sounds become neutralized within the modern soundscape, blurring the line between infrastructure and atmosphere.

But what does it mean to hear danger? And how does the sonic experience of warning differ between societies? Alarms are never merely technical signals; they are culturally encoded events that shape, and are shaped by, aural culture and the history of science. For some, sirens signal protection; for others they evoke trauma or failed systems. Scholars in sound studies have emphasized how public sound not only produces listeners, but also distributes agency and meaning across the soundscapes of modernity [1, 2].

This paper introduces the *Soundscapes of Warning* application, an experimental tool that seeks to defamiliarize alarms by treating them as cultural and aesthetic artefacts. Rather than natural sounds, they are understood as products with specific histories that reveal how societies construct the semiotics of warning. The project presented in this paper is a part of a larger project titled ”Soundscapes of Warning: The Past, Present and Futures of Viktigt Meddelande till Allmänheten (VMA)” (Vetenskapsrådet VR-SÄKER, 2023-05736, PI Marie Cronqvist) and which interrogates the cultural and infrastructural history of the Swedish air-raid siren.

2. The Cultural History of Sound Alarms

Before their deployment as instruments of civil defense, sirens were woven into the industrial soundscape: they punctuated the rhythms of factory labor, guided ships through fog, and signaled the working day

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across towns and cities [3]. During the Second World War and the Cold War, their howls became synonymous with looming aerial attacks and the vulnerability of civilian life. Today, however, many of these mechanical warning systems are being supplanted by digital and electronic solutions, rendering the wail of the siren increasingly a historical phenomenon—an acoustic trace of modernity that calls for cultural and historical interpretation.

The *Soundscapes of Warning* project continues and enriches this inquiry into sirens as cultural sounds. Drawing on Marie Cronqvist's work on the acoustemology of sirens in Sweden [4], it treats alarms as ways of knowing and governing through sound: signals that not only announce danger but also shape listeners, encode authority, and structure civic routines. We suggest to consider these sounds, not as neutral tones, but as historically and socially embedded artefacts. The project develops tools to make these sonic infrastructures comparable and explorable, combining historical research with experimental methods to understand how societies organize attention, memory, and vulnerability through sound.

3. Siren Scholarship

In *Sirens*, Michael Bull observes that the exclusion of modern alarms from critical discourse is striking; even within sound studies, warning sirens are often treated only in passing despite their central role in twentieth-century public life [5]. Much scholarship has instead focused on military sound, or what Steve Goodman in *Sonic Warfare* (2009) describes as the weaponization of vibration and noise—sound as attack [6]. By comparison, alarms and sirens—sound as defence—have often been neglected, even though their regular tests and sudden activations leave deep imprints on public memory.

More recently, artistic and scholarly projects have begun to foreground sirens as cultural sounds in their own right. Inquires into the early history of German alarm system have been reoccurring topic ([7], [8]). Whereas Aura Satz's *Preemptive Listening* (2018) and its associated roundtables frame them as instruments of sonic governance—technologies that summon publics, produce listening subjects, and delineate lines of protection and exposure [9].

The *Soundscapes of Warning* application builds on these insights by treating sirens as historically and culturally embedded artefacts. Drawing on acoustemological perspectives [4], it examines how alarms encode authority, vulnerability, and civic routines. By combining historical research with experimental visualization, it explores sirens not as neutral signals but as infrastructures of governance and collective attention.

4. Design and Development

The application is designed to estrange and reframe the auditory character of warning signals. Rather than treating alarms as functional audio, it presents them as historically shaped media forms with aesthetic, political, and cultural dimensions. The aim is to denaturalize warning sounds and allow users to encounter them as artefacts—both data and cultural record.

Each signal is rendered as a volumetric 3D structure using audio feature extraction. Building on earlier experimental audio analysis methods [10], these objects are interpretive rather than reconstructive: tangible, printable, and interactive forms that reframe short signals in ways once applied to extended broadcasts.

The development of the *Soundscapes of Warning* application also connects to ongoing interface experiments at the C^2DH. In particular, it builds on design strategies explored in the *3D Stories* project, which combined interactive models with narrative annotation to make historical artefacts accessible in new ways. Like that project, our platform uses three-dimensional forms not only for display but as vehicles for interpretation, linking cultural artefacts to broader research narratives. In this sense, *Soundscapes of Warning* represents a branch of this design lineage, extending narrative-3D methods from material history into the domain of public sound culture.

Built with a modern web architecture, the *Soundscapes of Warning* application is implemented in

TypeScript and React, bundled with the Vite framework for fast rendering and modular development. The interface runs entirely in the browser using pre-rendered audio data, ensuring stable performance and reproducibility. Visualizations are generated from structured datasets that can, in future iterations, connect to real-time audio APIs if formatted accordingly. The current build is hosted on the C^2DH servers (uni-c2dh.lu), following initial testing through Netlify, and the open-source repository allows others to fork and adapt the code for their own research interfaces. Designed as a framework rather than a fixed platform, it enables the generation of three-dimensional soundscapes from processed audio, parameter adjustment through frequency and amplitude filters, and export of models for analysis or physical fabrication.

4.1. Interface and Interaction Design

Figure 1: Opening globe interface of the *Soundscapes of Warning* application.

On entry, users encounter a globe that anchors sounds in geographic context. By zooming and clicking pinned locations, they access recordings and metadata, situating alarms as local expressions of sound culture. The interface is rendered directly in JavaScript, allowing for smooth interaction across devices without external software.

The globe reflects the project's broader design identity, which employs minimalist cartographic layouts, monochrome palettes, and restrained motion to question sonic standardization and foreground spatial difference. This visual language is shared across the larger *Soundscapes of Warning* project—appearing in publications, workshops, and installations—ensuring aesthetic continuity between research outputs. In this way, the application serves not only as a technical tool but as part of a wider design framework aimed at defamiliarizing warning signals and encouraging comparative listening.

4.2. Shaping Sound: 3D Visualization of Spectral Data

The core visualization method adapts spectrography into a three-dimensional form: frequency mapped to the Y-axis, time to X, and amplitude to Z. This produces sculptural terrains that make sonic profiles tangible. Developed in the mid-20th century for phonetics [11] and later used in bioacoustics [12] and seismology, spectrography translates the invisible into interpretable form. Following Sterne [2], we also

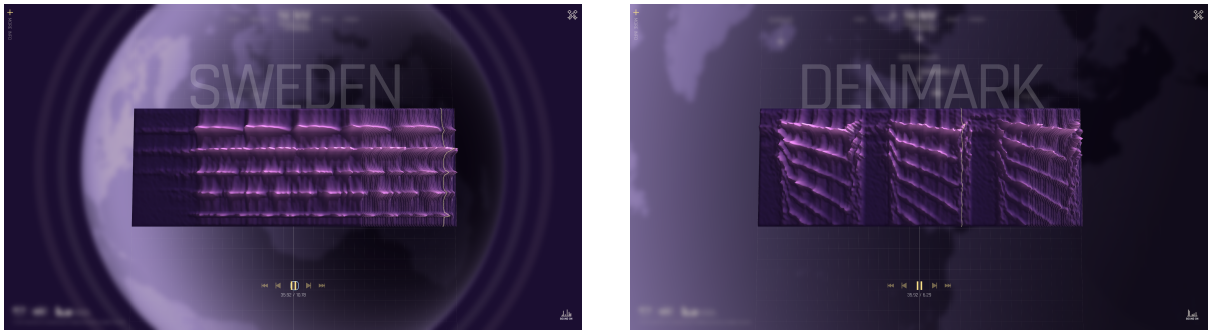

Figure 2: Visualisation of the Swedish and Danish alarm signals displayed next to each other.

recognize that such visualizations shape not only understanding but governance. In our application, spectrograms are rendered interactively in the browser; users can rotate, zoom, and pan the objects, extending listening into looking and interpretation. The shift from spectrogram-as-image to sound-as-shape is both aesthetic and conceptual, prompting reflection on how different signal cultures generate different geometries of alarm.

4.3. Metadata and Comparative Perspectives

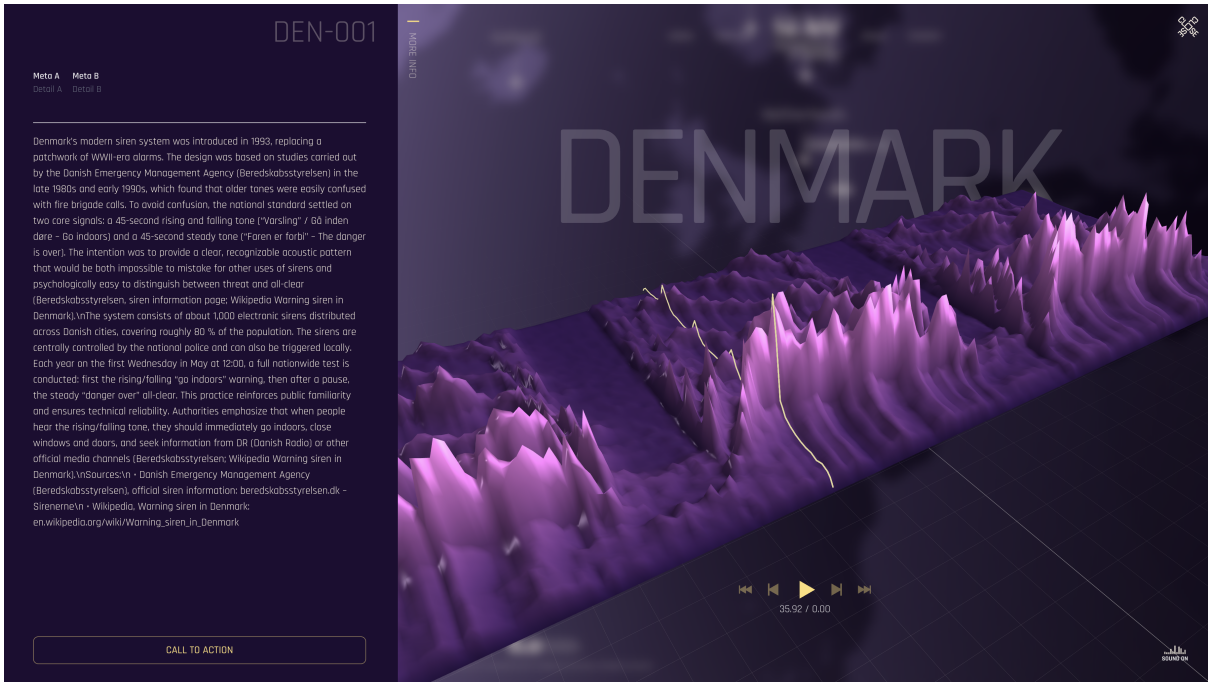

Figure 3: Metadata interface in the *Soundscapes of Warning* application.

Each alarm signal in the *Soundscapes of Warning* app is paired with metadata that situates it within a broader cultural and technical history. For now, this includes contextual notes gathered from national warning webpages, highlighting how systems differ in their codification, testing routines, and intended behaviors. Despite their ubiquity, the comparative history of national warning systems remains underexplored, making this layer of metadata a starting point for future research.

Planned updates will extend metadata to include precise recording locations and details about the devices themselves—such as air horns, rotating sirens, or electronic loudspeakers—since these material differences strongly shape the character of alarm sounds [3, 13]. By linking auditory form with infrastructural context, the platform not only catalogs signals but also opens pathways for comparative study

across nations and technologies.

5. Conclusion

At a time when warning signals are actualized with increasing urgency, it may also be time for scholarship to move siren sounds from the cultural periphery to centre stage. We hope that the *Soundscapes of Warning* application serves this dual role: guiding future research into the local histories of alarm while also opening these sonic infrastructures to a wider public as cultural artefacts. Though still ongoing, we aim to demonstrate how digital humanities approaches can make audible sonic cultures. By enabling comparative exploration, it invites both scholars and lay audiences to reflect on what it means to hear danger and how the semiotics of warning vary across cultural and historical contexts.

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