# SOUNDSCAPE AS A DESIGN TOOL FOR OPEN URBAN SPACES: AN ANALYSIS OF THE WATERFRONT AREA SURROUNDING THESSALONIKI CONCERT HALL

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***Abstract***
*In an age where cities and our planet are challenged by remarkable environmental, healthcare and social crises, open urban spaces are the catalyst for improving the quality of life of urban populations. Open spaces, if designed to be sonically pleasant, can serve as a refuge for recreation and restoration. Sadly, most cities are loaded with a plethora of chaotic sounds that have a negative effect on human wellness. Although sound acts as a "fourth dimension," which can contribute to how people experience and use space, the contemporary approach of spatial planning is limited to the quantified measuring of noise only. This means that there is a methodological gap in developing a toolbox for creating good soundscapes.*

*In this paper we investigate how the soundscape functions in correlation to open space and present a methodology regarding how soundscapes can be used as a design tool in urban planning and the design of public space, in particular. To this end, we present a study performed in the area of Thessaloniki Concert Hall, on the Eastern Thessaloniki waterfront. Our methodology for the soundscape analysis combines two methodological tools: a quantitative measuring of sound levels, conducted in strategic points, and a qualitative empirical analysis, based on the perceived, subjective experience of the soundscape by the user, according to four typology values: Energetic/Lively, Chaotic/Noisy, Indifferent/Dull and Calm/Soft. Using these values, we proceed to visualising the results by **experience/sound/ perception** mapping, creating a typology raster.*

***Keywords:*** *Open urban spaces, soundscape, mapping, urban design, acoustic comfort, noise, waterfront, Thessaloniki Concert Hall.*

## Introduction

### *The sonic environment*

According to R. Murray-Schafer, one of the pioneering researchers of the soundscape, humans are perpetually exposed to sonic stimuli, even if they cannot hear them (the human ear is capable of hearing a limited range of frequencies). Therefore, we are always in a sonic environment, with which we are in conversation. The sonic (or acoustic) environment, in correlation to spatial studies, was studied scientifically for the first time by M. Southworth

(1967) in the late 60s. Southworth claims that non-visual stimuli likewise have an effect in the quality of life within the city and it is important to find out how their manipulation could improve said quality. Sound acts as a link to (visual) reality and has the ability to protect and enrich it.

Due to the plurality and diversity of sounds, their classification may vary, depending on the context and aims of the research. Classifications could be quantitative (i.e. a classified Decibel scale), or qualitative. According to the school of Acoustic Ecology (Kuusiaho, 2016), all sound sources can be grouped in three categories: Biophony, Geophony and Anthropophony.

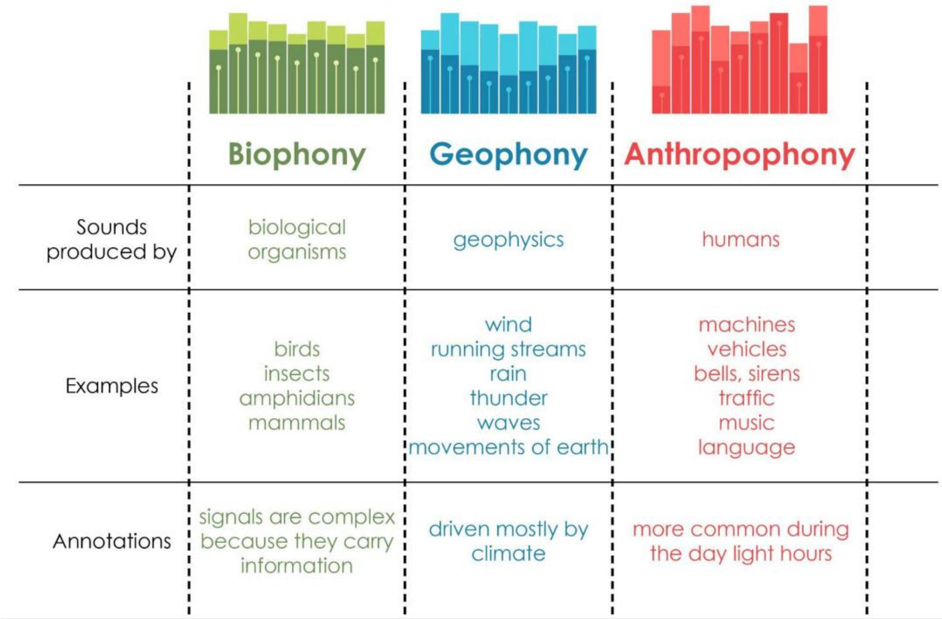


*Fig. 1:The three sound categories of Acoustic Ecology (Based on: Pijanowski et al., 2011a, 1213–1225).*

Subsequently, the sonic environment can offer information on the space's typology. Hedfors (2003: 56) builds on McHarg's (1969) model, proposing "the sonotope layer as one of the layers of information in landscape planning".

***Defining the soundscape***

There is no singular definition of the soundscape, as it serves multiple meanings that vary, according to the scientific field. However, the International Organization for Standardization (ISO *12913-1:2014*) defines the soundscape as: **"Acoustic environment as perceived or experienced and/or understood by a person or people, in context"**. The standard's conceptual framework separates the term "soundscape" from "acoustic environment", as the former is a dynamic field that can be recognized and designed, whereas the sonic environment describes a natural, default state. This standard, in particular, contributes to UN's Sustainable Development Goals no.11 "Sustainable Cities and Communities" and no.3 "Good Health and Well-being".

Furthermore, the existing bibliography has proven the dialogic relationship between the acoustic and visual (land)scape. Axelsson (2011) adds that the soundscape is the "acoustic equivalent to 'landscape'" and includes all sound sources, pleasant or not.

***Sound in urban environments***

Hedfors (2003) compares the sounds of a city to a never-ending musical event, one that can be managed with urban and spatial planning tools. The urban soundscapes create the phonic identity of a city, given that sounds play an integral part in creating a sense of place and a sense of belonging (Pouya, 2017). The sounds of cities fall under a particular soundscape category, where a multitude of sound sources co-exist in a clearly defined (and often cramped/narrow) space, drawing from all three groups of Biophony, Geophony and Anthropophony. In this case, Anthropophony sounds usually overpower the other two and are more versatile; For example, both the soundscape of a highway as well as the soundscape of a busy pedestrian street with commercial uses etc. can be considered as anthropogenic soundscapes. Therefore, in order to decode an urban soundscape, it is necessary to look at it as a mosaic of the soundscapes that compose it: the soundscape of the downtown city, the suburban soundscape, the soundscape of an avenue or a block, etc.

Pouya (184:2017) defines soundscape ecology as "the study of sound within a landscape and its effect on organisms". Acoustic ecologists claim that the quality of the urban sonic experience is in decline and as a result the urban soundscapes become progressively "lo-fi", dominated by monotonous sounds (traffic, construction, etc.). These sounds conceal/mask/cover up other, more delicate sounds, hence making them unidentifiable, contrary to a "hi-fi" soundscape (Schafer, 1977).

Irving et al.'s (2009) empirical study on green public spaces makes the following points:

- There is a connection between objective and subjective sound volume levels, as well as the type of sounds recorded. Even though there was a consistent quantitative hierarchy in the reaction to sounds, there was spatial differentiation, due to the ecological characteristics of green spaces that define them from the rest of the urban landscape.
- Mechanical sounds, mainly vehicular ones, are the most discernible and least preferred, regardless of sex or age.
- Green public spaces within a city centre are usually noisier and louder overall, compared to the ones located on the periphery of a city centre.

Jiang et al. (2018) propose, claiming that the correlation between quiet/noisy and comfortable/uncomfortable public spaces show that the soundscape is closely related to the user's perception of a space; Visual elements such as "greenery, water, view of the sea" and sonic elements such as "sounds of water and birds" elicit positive responses from people, in contrast to the visuals and sounds of cars and traffic. Consequently, the soundscape affects our experience of being in a public space, either by itself or combined with its landscape equivalent.

***From "sound" to "noise"***

Sound turns into "noise" at the point where its volume exceeds certain Decibel values or the sound itself is deemed harmful to wellbeing. However, in reality the common listener defines noise in a highly subjective manner.

The World Health Organization (WHO Europe, 2018. Via EEA, 2023) states that exposure to vehicular sound pollution should not exceed 53 dB during daytime ($L_{den}$)and 45dB during the nighttime ($L_{night}$). According to the EU, traffic-related sound pollution is particularly crucial, in both urban and rural areas. Over 95 million Europeans are exposed to car noise over 55dB $L_{den}$ and over 65 million are exposed to over 50 dB $L_{night}$, which corresponds to > 20% of urban population across all member states and even 50% in certain cases.

According to Pouya (2017), there are three types of noise:

- Unwanted sounds
- Non-musical sounds (with non-periodical soundwaves) and
- Any loud sounds

Furthermore, **noise is often received subconsciously**.

Spaces with ambiguous forms and a condensed acoustic foreground can confuse the listener, by corrupting useful sonic information: such soundscapes occur around busy avenues or highways. Moreover, loud sounds that dominate the acoustic foreground may grasp the user's attention but ultimately offer useless information (i.e. the general presence of cars or humans). The sounds that are actually useful are more delicate, fainter and do not take place as often (Southworth, 1969).

The design of soundscapes differs from noise management. Noise management measures are more systematic, focus mainly on arithmetic data and can be grouped in three strategic actions: controlling the source, managing the transmission path between source and receiver, and protection of the receiver (Hedfors, 2003). Conventional study of noise seemingly focuses on technical risk evaluation, however there is little attention on developing a theoretical framework for creating pleasant soundscapes. Noise management puts spaces in a binary "positive-negative" scale, rarely proposing strategic solutions. On the other hand, musical research has significant terminology, but is limited to analysing musical compositions or one-time sonic events, rather than the daily acoustic environments (Fowler, 2013).

***Soundscape properties & classifications***

Similar to urban form as analysed in Kevin Lynch's classic book The Image of the City (Lynch, 1960), in sound planning, too, there are **points, surface and linear elements**. Sonic areas (analogous to *districts* - one of the five elements that constitute how urban form is perceived, according to Lynch) can connect with each other through sound corridors (or paths, to use Lynch's terminology), or with structures like stepping stones. These tools can also be used in deploying "sound shelters", available for citizens in small, sustainable distances. Such shelters could be in the form of parks, pedestrian streets, or landscapes with special acoustic features. Regarding point elements, in analogy to the landmark, soundscapes contain ***soundmarks***, i.e. unique sounds that essentially define sonic identities of different cities (Rehan, 2016; Karapostoli, 2016).

The first step in identifying and recognizing a soundscape is the detection of the **source-receiver** dual. In the case of urban soundscapes, the receiver is the human and, depending on the current situation or project in question, they can belong in a specific target group. For example, the soundscape of a playground has the children playing and their companions as receivers. Hedfors (2003) also refers to the **transmitter,** i.e. any object/surface on which the sound waves fall and reflect, before reaching the receiver. In the equation of a soundscape, transmitters act as the variable, as their material, shape and placement in the soundscape's physical realm can drastically change the receiver's experience: Open landscapes allow for the sound to disperse easily while dense landscapes, containing many objects (e.g. a forest) reflect sounds easier (eg. the birds). Hence, **the transmitters in a soundscape also determine its own sonic behaviour.**

The need for systematic categorization of soundscapes and comparison of findings results in the creation of models. The Model of Prominence (Hedfors, 2003; McHarg, 1992) has the variables Intensity and Clarity on its axes. Depending on the soundscape's profile in its figure and background, four descriptive names occur: clear/strong and soft/crowded. Other models use functions, linear illustrations, or value intervals on an orthonormal axis system.

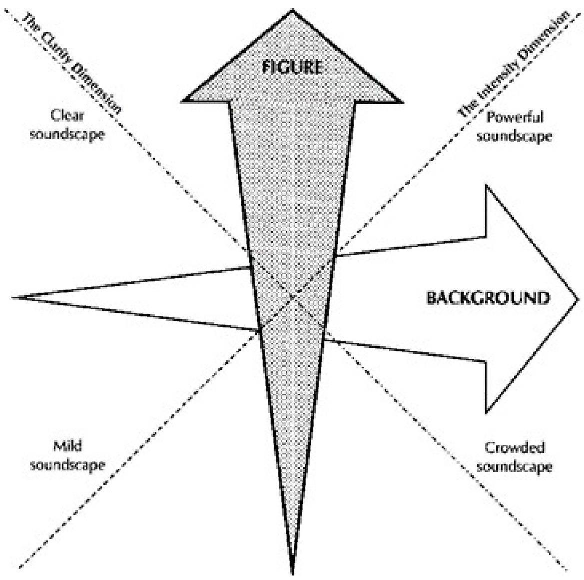


*Fig. 2: Model of Prominence. Source: Hedfors: 36, 2003.*

Tomlinson (2019) also refers to the triptych:

- Interrupting Sounds: sudden sounds that don't fit in the soundscape's context. They may be too loud or disturbing (motorcycle that runs in a quiet residential area)
- Masking Sounds: they can cover entire frequency bands (Air conditioning, ocean, traffic). The human ear has the ability to remove these sounds.
- Intentional Sounds: all the sounds in the foreground of the soundscape, like a human talking. However, masking sounds, like the sea, can move from the background to the foreground and become soundmarks, creating identity for an area.

Southworth (1967) confirms that sounds are experienced more comfortably at low-medium frequencies. Other qualities of pleasant sounds include uniqueness, descriptiveness, connection to human-centred activities or an indication of local culture, such as birds, footsteps, human talks or whistling. Quiet soundscapes, albeit necessary to exist as enclaves within cities, can become unsettling if the silence is absolute. They should be enriched with delicate, but clear and descriptive sounds (i.e. movement of water), so that the listener is not hesitant to enter the space.

***Benefits of successful soundscapes: multisensory approach, critical thinking, the social aspect***

The sense of hearing, although less sharpened compared to that of sight in a (fully abled) human body, remains valuable in collecting information about the world around us. There are no completely separate sensory spaces, as the senses are influenced by each other. The landscape and the way that we experience it, should be investigated with all our senses. The creation of spaces should, therefore, be synesthetic (Hedfors, 2003). A soundscape with positive attributes has been proven to help concentration, while it can itself be turned into an educational process. This is especially important for children: they should be encouraged to actively listen to sounds, especially the most delicate, most subtle ones (Pouya, 2017).

Fowler (2023) also emphasises the importance of "critical listening". A large part of the population are passive listeners and only a minority actively tries to hear. Schafer (1992)notably mentions that it is important to be open to different hearings and not to listen passively.

Sound also has important emotional and social effects, which can be seen when it is removed from a landscape, whose image then changes drastically. Eventually, the soundscape alone could alter the mental health conditions of an entire community, and its design is a way to make a city less stressful, more pleasant and descriptive for users.

The main goal of shaping the urban soundscape is to incorporate sociological and aesthetic values into the acoustic urban environment. The sub-goals include (Rehan, 2016):

- To provide the listener with a sense of place
- To find and protect quiet areas
- To promote healthy lifestyle, comfort, communication, safety, and wellness
- To enhance the visual image of cities
- To mitigate the urban island effect and improve air quality
- To improve the feeling of calmness in open spaces
- To promote activities such as walking and running, for the benefit of mental health
- To play an important role in tourism, thus to bring great economic benefits
- To create fertile ground for financial investments

Sound design can also turn out to be more financially efficient compared to large, radical interventions. Southworth (1967) mentions that a dull area can easily gain character if it is covered with an extra layer of sound (see Hedfors, 2003; McHarg, 1992).

Sounds and their receival/acceptance are also an issue of equity, especially for people with physical disabilities. The inability to access a stimulus in a public space can be a phenomenon of social exclusion (a blind person cannot move easily if they have difficulty hearing or touching the space, a deaf person has a limited ability to receive audible information beyond their field of view).

***Sonic (and landscape) design***

At the urban design scale, the sound design applications of an area (if existent) are usually a derivative (indirect or direct) of landscape design and architecture. Pouya (2017) notes that, similar to landscape design, soundscape design involves the design and organisation of managing the sonic environment of a place in such a way as to ensure the improved human perception of it.

In the practice of architecture, the acoustics design of theatres and concert halls is a standalone and particularly extensive field. However, a concert hall is designed in order to create a fully predictable and manageable state, a logic that significantly differs from the design of outdoor spaces, where sounds occur spontaneously, organically and depend on the weather or environmental conditions, something that is not only accepted but should be welcomed as well. Thus, there is a limited variety of tools from the fields of urban design and landscape architecture, as well as lack of conceptualization, as the definitions are diverse and come from different scientific fields.

Any design intervention in the natural space potentially changes the soundscape, yet the natural environment always outlines the primary soundscape. Fowler (2013) emphasises that topography is an essential factor to the design of soundscapes, as it has the ability to filter, underline or hide sound sources. The shape and morphology of the space, although not always possible to change, can be freed from enclaves of high reflectivity, where sound is reproduced and multiplied to a chaotic result, by placing sound-absorbing materials. Along with noise reduction, it is useful to provide bioclimatic spaces within a city, where the microclimate creates silent oases (Southworth, 1969).

Trees and vegetation play a significant role in noise management, as they reflect and/or absorb sound energy. Dwyer et al. (1992) estimate that 33 m of forested area corresponds to a noise reduction of 7db, while other studies show that direct noise can be reduced by 50% by wide belts of trees and slopes as well as soft, porous soil. Designers also have to take into account the sound of “hardscape”[2] . Certain materials, such as cobblestones, amplify the sound when it rains or snows, while the sound of human footsteps resonates significantly against stone, wood, asphalt, soil, etc.

Conceptually, the act of designing space is usually implemented in urban areas, where the human presence is dominating. As a result, the design and management of acoustic environments mainly focuses on anthropocentric sounds and the first step in tackling urban noise is limiting sound pollution caused by motor vehicles; hence, mobility management plays a substantial role in alleviating noise pollution in urban areas. Amongst the many mobility management policies, Shared Street Design (Global Designing Cities Initiative, no date) aims to limit car dominance and promote walking and biking, activities that turn streets into places to be, thus increasing acoustic comfort and the feeling of security. Other mobility-related measures in the same category are traffic calming, self-explaining roads and “road diet” (Huang et.al, 2019). Hedfors (2003) also refers to “Quiet environments”: Common in the Swedish planning system and applicable to different planning scales, they mostly include sound measuring and proposing sound limits per designated land use. However, in this case, both pleasant and unpleasant sounds are evaluated in the same way.

There are different approaches to whether we should recreate and design the space in order to obtain a desired acoustic condition. However, especially for urban public spaces, participation in the design of their spaces and soundscapes is imperative. Ground-up initiatives are also necessary in the manifestation of such cities.

**Case Study: Thessaloniki Concert Hall’s Waterfront**

The study area is located on the south end of Thessaloniki’s municipality and is commonly known as the waterfront of the “Depot” district, with Thermaikos Gulf serving as its west border. The area shares its southeast border with the municipality of Kalamaria and includes the coast of Kellarios Cove, a marine sports club, swimming pools and open air courts, Thessaloniki Music Hall’s building complex, a middle school courtyard, and a large open area that over time has turned into a parking spot.

The study area’s northern end marks the beginning of the Nea Paralia waterfront, the linear promenade with bike lanes, parks and recreational uses that spans across the city’s waterfront, all the way to Thessaloniki’s Harbor, located in the northwest of the city. In an almost paradoxical manner, despite the study area being part of this continuous waterfront (it is the estuary of the metropolitan area’s continuous urban fabric), based on the user’s visual and perceptive experience, it seems cut off from the continuous waterfront. Considering the fact that the area’s western limit/border is the natural coastline to Thermaikos Gulf, its connection to the element of water is intimate, as it is omnipresent visually and sonically. However, urban plans have yet to introduce a successful, concise vision for this part of the waterfront, leaving the area fragmented. Between the designed, linear waterfront and a fully natural coastline, the sharp, non-organic geometry creates a “third space”, serving no apparent purpose.

The study area represents 20% of Thessaloniki’s waterfront in length, serving as a transitional area between the historical centre and the eastern suburbs, in proximity to the airport. Based on all of the above, as well as the fact that the area is surrounded by multiple sites of cultural and architectural interest, the study area is a hyperlocal area of interest in the city’s general context.

[2] Structures (such as fountains, benches, or gazebos) that are incorporated into a landscape. (Merriam-Webster Dictionary, accessed 8/3/2024)

## Methodology

### *Urban analysis*

In order to understand the surrounding area's dynamic, an urban stock analysis was conducted, as it is a standard procedure in urban projects. The analysis consisted of a set of thematic maps, showcasing land use of floors, building heights, state and dating of buildings, architectural morphology and typology, the analogy between built and unbuilt space, existing traffic conditions and transportation routes, the typology of open public spaces and their materials. These maps have shown that the area is close to the dense, continuous urban fabric with mid-high rise buildings and mixed land use, but is cut off from it due to the street and the site of the abandoned Allatini factory of the late 19th century.


*Fig. 3: Thematic maps from the urban analysis of the greater site area.*

### *Activity Mapping*

Part of the user's lived experience is determined by how the space is used. The activity map is based on data collected during the site visits and images compiled in advance. Based on the map, most recreational pedestrians walk across the edge of the waterfront where there are no visual or sonic obstructions. Even though the designated sidewalks on the street may be the shorter route, people prefer to make a detour to walk closer to nature. The large open area lacks interest so there are limited passers-by. Finally, Kellarios Cove is a frequent rest stop and quiet refuge from the urban realm, but has limited seating.


*Fig. 4: Activity map.*

***Soundscape Methodology***

The study of the site's soundscape is divided in two parts: A quantitative measuring of sound levels, and a qualitative analysis of the site's sonic features.

The quantitative measurements resulted from monitoring and documenting the area's soundscape in the span of two days, while the feature documentation further included comments from personal experiences and casual observations, prior to the site recordings. In order to cover a wider range of pedestrian and vehicular traffic and produce realistic results, the soundscape recordings were conducted in various hours and weekdays. The study was conducted in 16 strategic points, scattered around the study area. The placement of these points was based on the preliminary urban analysis and user activity map. Furthermore, each point represents a sub-region with shared sonic attributes. In the soundscape maps, the sounds are shown sorted from most to least noticeable (based on user perception).

The points can be grouped in three spatial categories:

- **Category A:** Points in proximity to Maria Callas Street: A1, A2, A3, A4, A5.
- **Category B:** Points located by the sea/ at the waterfront, including the perimeter of Thessaloniki's Concert Hall and the open area used as a parking lot: B1, B2, B3, B4, B5, B6, B7, B8.
- **Category C:** Points within Kellarios Gulf's coastal area: C1, C2, C3.

During the recordings, four sonic values were recorded:

- The Average sound Level **(Avg/Leg)**
- Maximum Value **(Max)**
- Minimum Value **(Min)**

- Peak Value **(Peak)**: Peak Values correspond to Interruption Sounds. They may override the mean variance, but don't change the average (a singular event cannot alter the soundscape's profile)

The measuring of the site's sound levels was conducted on smartphone application "Decibel X" for IOS Software, due to its ease of access. The documentation for every mark, especially for the Average values lasted for >5 minutes and an additional 30'' recording excerpt, that best represented the area's sound profile, was saved. Using these measurements, each mark had two Sound Reports, one per site visit. The statistical data from the recordings were then classified in defined intervals of 5 units each, in order to be mapped.

## Results

Recording 1 took place on a Friday at 13:00, noon. The weather had sunny intervals, with brief rain showers. It was a working day, with low levels of human traffic. The lowest value was recorded at 50dB, and the maximum reached 85dB. The loudest point was located on the street (point no. A2), the volume reaching 76.5 dB. All points close to streets are sonically dominated by sounds of cars in motion, especially accelerating vehicles. According to Tomlinson (2019), motor sounds in this case are considered "masking sounds" and are in the foreground, concealing the rest of the acoustic elements.

*Fig. 5: Recorded dB values, Recording 1*

| Friday13:00 | Avg/Leq | Max | Min | Peak |
|---|---|---|---|---|
| **A1** | 75.4 | 85.5 | 60.0 | 89.0 |
| **A2** | 76.5 | 92.0 | 43.4 | 94.3 |
| **A3** | 67.2 | 77.0 | 49.3 | 82.6 |
| **A4** | 65.4 | 74.9 | 45.2 | 78.2 |
| **A5** | 69.8 | 79.6 | 47.5 | 80.9 |
| **B1** | 56.6 | 66.4 | 44.5 | 74.5 |
| **B2** | 54.1 | 66.3 | 44.4 | 73.6 |
| **B3** | 49.6 | 60.5 | 44.2 | 66.7 |
| **B4** | 52.3 | 65.4 | 45.4 | 73.3 |
| **B5** | 51.6 | 65.4 | 42.9 | 74.2 |
| **B6** | 57.1 | 70.6 | 44.2 | 72.1 |
| **B7** | 61.9 | 75.3 | 44.11 | 79.9 |
| **B8** | 61.6 | 79.5 | 44.9 | 88.9 |
| **C1** | 52.3 | 62.5 | 44.9 | 69.6 |
| **C2** | 61.0 | 74.4 | 47.0 | 82.1 |
| **C3** | 50.7 | 63.5 | 43.0 | 68.6 |

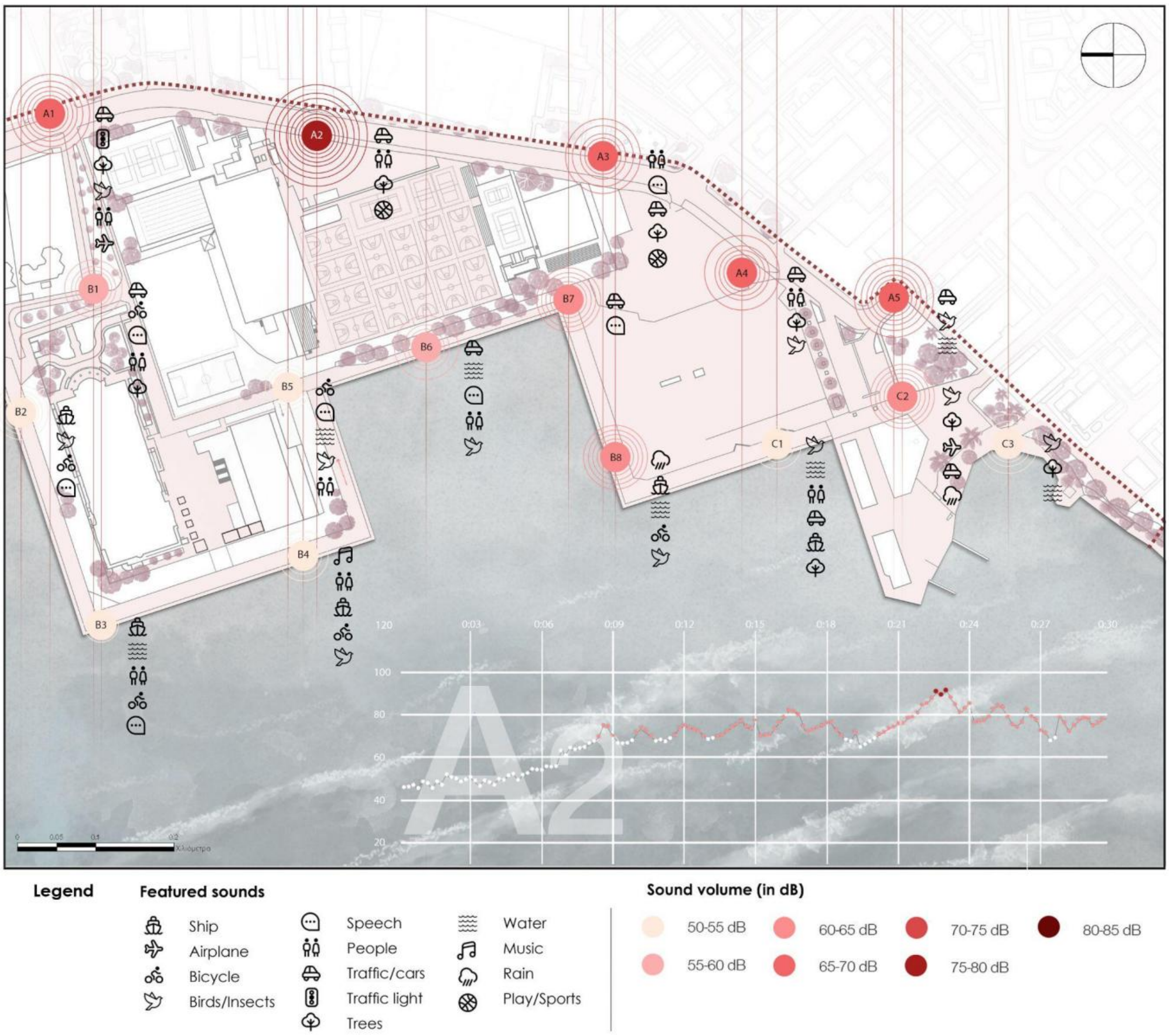


*Fig. 6: Soundscape map of Recording 1.*

The second recording was conducted on a Sunday, starting at 19:00. The area was busy, both in vehicles and pedestrians, since it was on a weekend, with sunny weather and a gentle breeze. Most importantly, sunset is the waterfront's rush hour. The day of the recording was specifically selected because a concert was taking place at Thessaloniki Concert Hall, meaning that car traffic, taxi lanes and parking spaces would be reaching maximum capacity. At first glance at the data, a collective rise in average Decibel values is evident, compared to the first recording. Based on the data, sound levels across all 16 points have higher values, including soundmarks/Peak values: more frequent plane landings, bells of passing bikes, exclamations or loud human conversation.

*Fig. 7: Recorded dB values, Recording 2*

| Sunday 19:00 | Avg/Leq | Max | Min | Peak |
|---|---|---|---|---|
| **A1** | 63.5 | 54.4 | 73.8 | 77.8 |
| **A2** | 68.4 | 83.6 | 52.4 | 91.8 |
| **A3** | 65.6 | 75.5 | 55.7 | 79.7 |
| **A4** | 71.1 | 85.2 | 53.7 | 86.1 |
| **A5** | 68.7 | 83.1 | 53.6 | 88.3 |
| **B1** | 55.4 | 66.2 | 48.3 | 69.5 |

| | | | | |
|---|---|---|---|---|
| **B2** | 74.3 | 89.8 | 51.5 | 95.4 |
| **B3** | 85.9 | 96.7 | 52.4 | 101.2 |
| **B4** | 80.7 | 72.2 | 55.2 | 99.1 |
| **B5** | 68.6 | 80.3 | 53.9 | 85.2 |
| **B6** | 66.3 | 80.6 | 49.7 | 85.9 |
| **B7** | 68.3 | 81.9 | 51.2 | 84.8 |
| **B8** | 70.9 | 84.3 | 52.4 | 88.8 |
| **C1** | 67.9 | 78.5 | 52.5 | 85.2 |
| **C2** | 65.5 | 78.1 | 50.2 | 83.2 |
| **C3** | 63.8 | 76.0 | 49.4 | 81.9 |

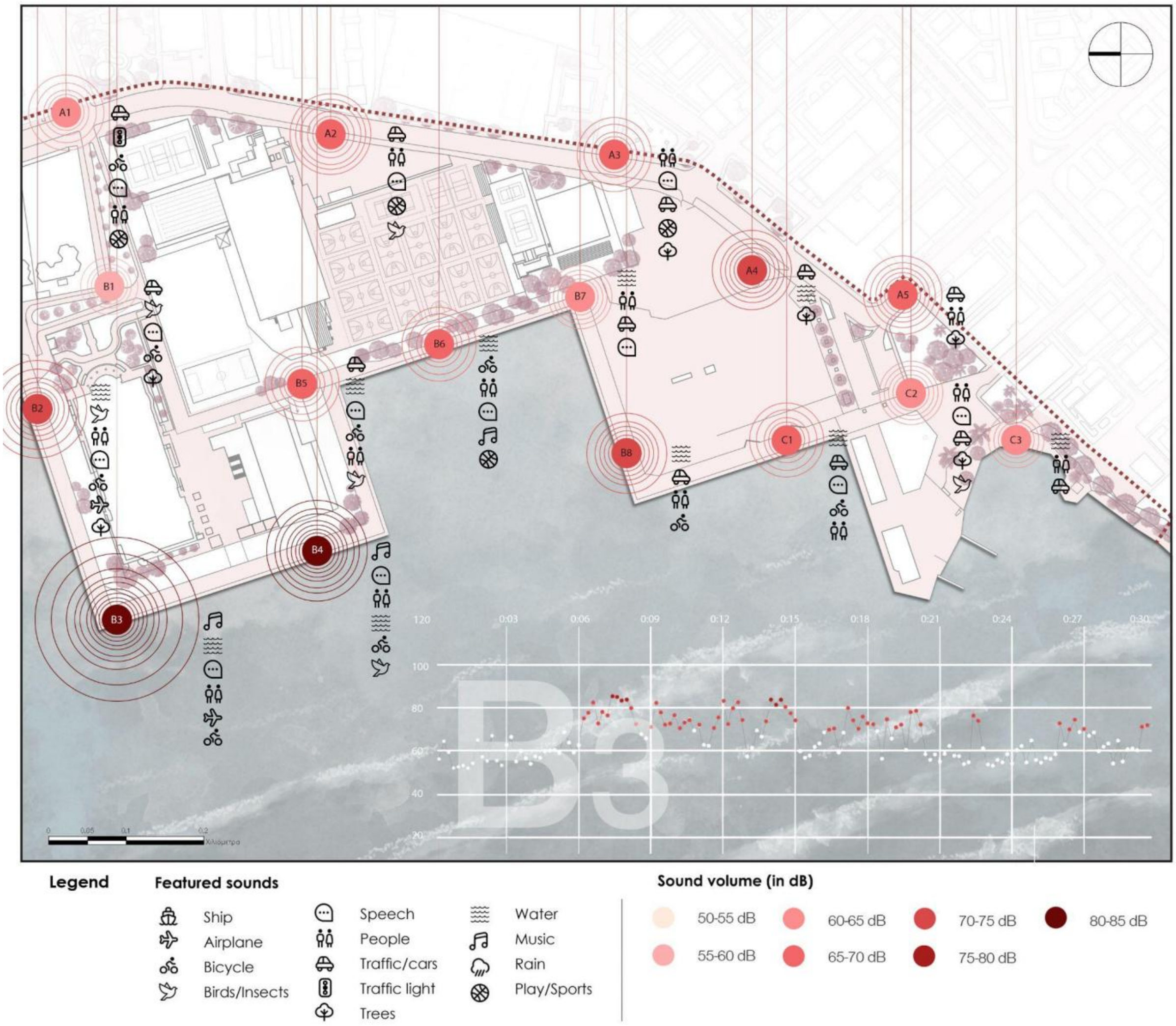


*Fig. 8: Soundscape map of Recording 1.*

The highest value of this second field visit was recorded on point B3, reaching 85.9 dB. Although that part of the area is not closely related to annoying sounds, such as cars and motorcycles, this point is essentially louder, compared to point A2, located on the busiest street (Maria Callas St.) of the study area. It is also worth noting that, during the afternoon recording, new sounds were added in points B3 & B4, due to musicians busking nearby. These sounds are part of the soundscape's foreground.

## Discussion

The area's sonic profile is a mixture of mechanical, anthropogenic, and natural sounds. The study area is located just 7.5km from the airport, so the particularly prominent (mechanical) sounds of aeroplanes landing tend to occur often, especially during the tourist season. The most important natural element is the sea, representing the area's sonic identity. Water, combined with vegetation (albeit limited), depends highly on the weather conditions. These elements corresponding to Biophony and Geophony, show variability depending on the seasons and weather conditions: The stronger the wind, the louder the sound of waves; when it rains, the pedestrian can hear the droplets on the leaves and solid surfaces. The sound of waves is generally perceived as calm and peaceful, contributing to the pleasantness and wellbeing of the visitors and residents. The sound of water in itself is an attraction, bringing interest to the area's overall environment.

Due to its topographic location, the study area presented two consistently different states of the soundscape, creating different acoustic identities. The "image" of the soundscape, followed by the visual messages of the landscape, create differences between the east and west parts of the area. Along Maria Callas Street (the eastern border) there are many car-based sounds and their echoing, whereas the western parts mainly have natural sounds.

During the afternoon recording, higher dB values were recorded across the waterfront, despite the sounds themselves being perceived as pleasant, nature-based, and somewhat relaxing. During the second site visit, more pedestrians were seen walking, engaging in conversation, or simply observing. More frequent presence of bikes was also noted, contributing to the soundscape accordingly. The increased human traffic, liveliness, and thus sonic variety at that particular time, is strengthened from the concurrent concerts, events, tournaments etc. in the area. These sounds are generally perceived as positive and, even though the soundscape is louder, there is no discomfort. This is something that the volume data fail to show by themselves, because in such practices all sounds are assessed as equal, but in reality, are experienced differently. Just because a sound is objectively of high volume, it doesn't negatively affect the user's perception of the soundscape.

Based on the sound feature data, point A2 who, in the first recording marked the highest dB value recorded, the most noticeable sound was that of cars and is followed by sounds of walking, speech, athletic activities (sounds of balls falling on the court ground), while the most concealed sound is that of the birds; the user has to hear attentively and actively, bypassing the louder sounds, in order to reach the delicate sounds of the background. Based on this recording, some sounds, based on their duration and volume, remain to the soundscape's background and other sounds and others are heard and experienced more intensely, moving to the foreground.

It is generally noted that the sounds noted in categories B and C, at the edge of the waterfront, is usually of lower volume. From a typology standpoint, there are fewer motor sounds and the more organic anthropophonic sounds of people stand out. In general, the sounds are perceived as nature-based and relaxing/soothing. In the first recording, where there was less activity on the edge of the waterfront, therefore the user can hear the distant sounds of the moored ships in the gulf, which can be rarely heard in the afternoon hours.

## Proposal for a typological analysis of the soundscape

In order to create an analytical tool for mapping the sonic character of the environment, we propose our own typology of sounds, related to the kind of ambience they create. Based on the quantitative and qualitative elements depicted in the sound maps, the proposed Sonic Assessment Model is drawing from the Prominence Model (McHarg, 1992) and the terminology regarding hi-fi/lo-fi soundscapes (Schafer, 1977) and it is configured by two assessment variables placed on the x-y axes:

1. **Volume,** as in the objective recorded dB values of the soundscape,
2. **Pleasantness**, as in the experience of the soundscape by the user.

The four types that occur are shown below (Fig. 9):

- Soft-Calm,
- Lively-Active,
- Indifferent-Boring,
- Chaotic-Boring.

Calm and Lively sounds are perceived as pleasant sounds, whereas Indifferent and Chaotic sounds are perceived as unpleasant sounds. Soft and Active soundscapes carry clear and delicate sounds, therefore representing hi-fi sonic environments, corresponding to a desirable situation that should be expanded on. On the contrary, Boring and Noisy (unpleasant sounds, regardless of volume) contain masking sounds and represent problematic areas. The values were used in sound perceptionmapping, creating a typology raster. When we apply this model in the study area, the produced map visually communicates the dynamic variation in the area's sonic character, showing how the user experiences different soundscapes in different zones (Fig. 10).

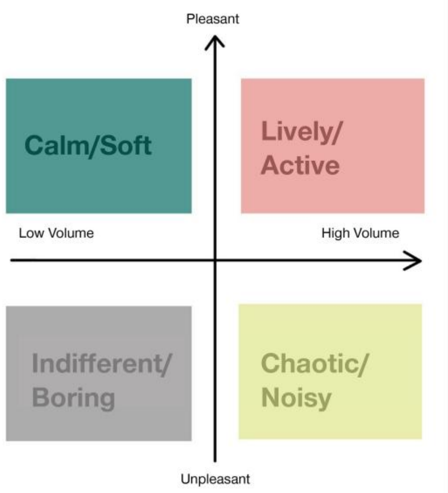


*Fig. 9: Soundscape typology model. The colour palette chosen for the mapping process is based on the principles of synaesthesia (the colour green corresponds to peace and tranquillity, etc.).*

**Chaotic/Noisy Typology**: A zone of chaotic soundscape develops alongside the street. As the user moves away from the main road of the area, entering the site itself, the soundscape forms sonic sub-areas, as seen in the taxi cul-de-sac and the entrance to the underground parking. It is noted that, during the site visit, discomfort and the struggle to hold conversation were noted due to traffic sounds. The street area is considered an example of. «lo-fi» soundscape, characterised by a monotony of sounds, which dominate and mask softer sonic stimuli. The user finds no sonic interest and tries to ignore the noise, listening passively.

**Indifferent/Boring Typology:** It is the most common in the area, mainly in parking spaces. These spaces are characterised by a lack of activities or points of sensory interest, urging the user to pass by the area, rather than stay in it. The same typology is repeated in spots around the concert hall. These sub areas are not chosen by the pedestrians. It is also noted that the space lacks shading and urban equipment. Compared to the developed waterfront. However, on the days with clear weather, more pedestrians tend to move around the emptier areas; These are mostly young people that sit on the edge of the waterfront where the contact with the natural elements of the water in the horizon is unobstructed. This behaviour showcases the potential of the space, despite its spatial deficits.

**Lively/Active Typology:** It bears a strong connection to movement and human voices, as well as child play, biking, and athletic activities. This type is present in areas with more human traffic and activities. It is noted that, during the recordings, it was experienced as a pleasant state of the soundscape, despite some sounds exceeding volumes of 80 dB. Therefore, it is confirmed that it takes more than just loudness to make a soundscape unpleasant. Active soundscapes occur from laughter or human speech are sounds with clarity, either in the foreground or background.

**Calm/Soft Typology:** This category is the most dispersed throughout the site. It is connected to the presence of greenery and trees, as well as sitting areas. Since the qualitative research also includes personal experience, soft soundscapes were completed by an undisputable feeling of comfort. Even though those areas may lack seating options, the user still tends to stop and actively listen. A variety of sounds could be heard. However, they never exceed the volume of human speech. In these cases, natural sonic elements come to the foreground, such as birds or the sound of tree canopies. A positive observation is that the pedestrians crossing or sitting by the cove would instantly lower the sound of their voice. This is an almost subconscious reaction: In Sonic environments with delicate sensory stimuli, the user chooses to observe and actively listen, a rare occurrence in the urban realm.

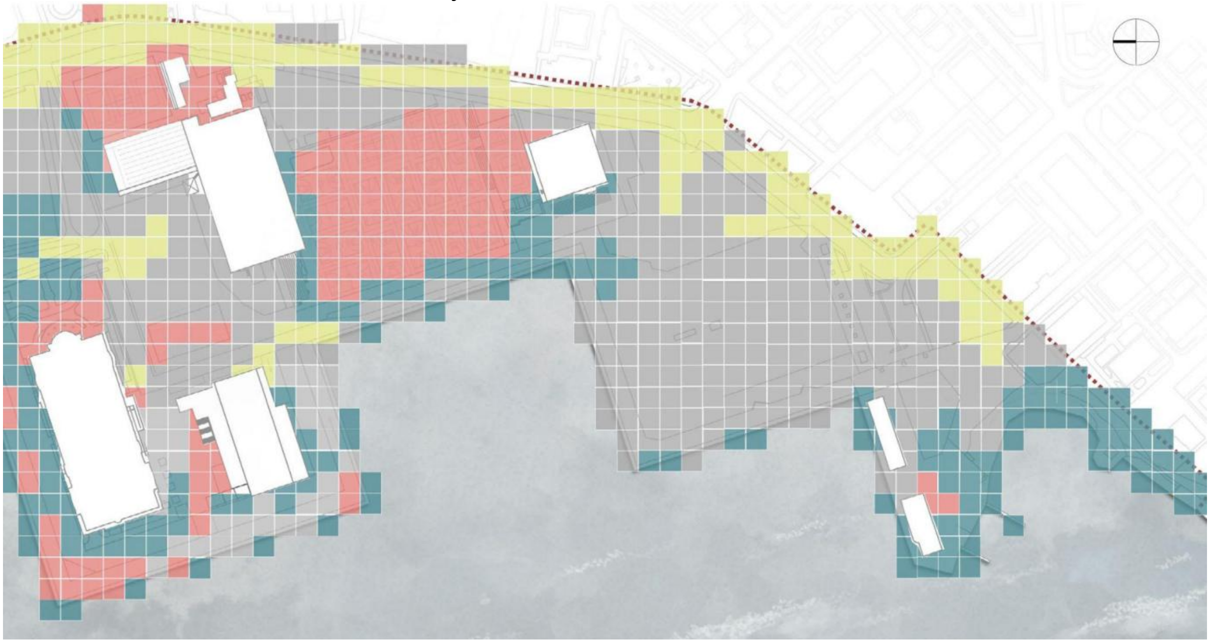

*Fig. 10: Soundscape typology raster map, based on the proposed model.*

**Conclusions**

The bibliographical research has confirmed that the field of urban design has started to move on from vision-dominated perspectives towards more multifaceted approaches in planning, by implementing the other senses, too, in the design process (Sharma, 2023). In terms of the auditory parameters of urban space, the works by Southworth and later Murray-Schafer, set the foundation for sonic design as a scientific field. The conceptual gap between the musical soundscape and noise design continues to exist, however newer researchers have already begun breaching the gap.

In our study, data analysis showed that the area of interest, albeit a waterfront with a strong presence of nature, serves as a transition point between two municipalities and two waterfront identities: the redeveloped and the natural. The site itself is spatially fragmented, underutilised and, despite its potential, lacks visual and sonic interest. The state of this urban gap is due to the strong vehicular presence and impervious surfaces of the cityscape. The sound analysis proved that any negative perception of space noted is strongly tied to noise. Furthermore, negative soundscapes in urban environments are synonymous to traffic and vehicles, followed by the lack of green/natural urban landscapes.

In this paper, we attempted to create a methodology that uses the subjective lived experience of the soundscape as a systematic, hands-on tool that can be integrated into the design process. It can contribute to reviving urban spaces sustainably, cost effectively and at human scale. The model presented in our methodology is fully adaptable: Based on the scale of the urban project, based on the space's attributes, based on what sonic result we want to achieve, the typology can change.

Beyond specific open public spaces, at the city level, it is important to look at a city's soundscape as a mosaic of smaller soundscapes: the suburban soundscape, the pedestrian street, the downtown centre. Calm and energetic soundscapes are more inviting; the user gets involved in the sensory environment. By mixing the two, we create pleasant soundscapes. Our goal as planners is to create urban landscapes that turn lo-fi into hi-fi soundscapes. Soundscape analysis itself should be used in urban design and planning as a dynamic tool, important for decision making, as contributing to socially just, culturally aware and environmentally sustainable practices.

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