Addressing soundscape deterioration:

Strategies for mitigating noise pollution in areas affected by overtourism

Bachelor Thesis

Theme
01. Exploring Healthy City Design at the Neighborhood Level: A Research-by-Design Approach

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Abstract

This project aims to solve one of the most concerning issues of overtourism in Europe, noise pollution. Besides expressing how nocive noise can be for the well-being of the inhabitants of a certain area, the project will also explain how congestion of people on extremely touristic sites is an overlooked case of sound pollution. This issue will be the link between the concept of a Healthy City and overtourism. In general terms, the goal of the project is to provide strategies to minimise sound pollution emanating from touristic areas without hindering their attributes.

The chosen location for the design is a historic open space in Barcelona that has recently received attention from visitors due to its amazing view of the city. This site has an adjacent residential area, which makes it an ideal location to develop a design that tackles the aforementioned issue of noise pollution. Ultimately, the goal is to protect the needs and interests of visitors and residents alike, thus improving their relationship with the city and one another. As a research-by-design project, three different approaches to a soundscape framework have been analysed. From these, three complementary strategies have been chosen to be a part of the final design. These strategies are the installation of sound barriers, strategic landscape through greenery, and the modification of access points to the site. The actual success of the final design will not be tested, as this project does not envision its actual implementation. Nonetheless, the resulting research paper will provide a possible solution to an existing problem and relevant insight on the topic.

Keywords: Healthy City, overtourism, noise pollution, soundscape, Turó de la Rovira; research-by-design

Table of contents

Table of figures

Introduction

Background

1,7 million tourists visited Barcelona in 1990. In 2018, the number went up to 32 million (Burgen, 2020). Although there have been Olympic Games in between - which ignited visitors' interest in the city - it is undeniable that the share of tourists in the city has skyrocketed. Burgen (2020) explains how this phenomenon created a wave of what was called 'turismophobia' in 2017. Coinciding with the refugee migration from Syria, the streets of Barcelona suddenly appeared with graffiti stating "Tourists go home. Refugees welcome." Since then, similar movements have appeared all over Europe's most touristic areas, and the slogans, protests, and anti-tourism strategies have evolved, but the situation has not been resolved (Burgen, 2020). These movements aimed to protest against the negative outcomes of the tourism industry. Generally, it was argued that this approach to tourism was not only detrimental to the housing market and environmentally harmful but also damaging to the overall well-being of neighbours, thus harming the health of the city (Pasma, 2022).

This research paper will focus on the principle of well-being from a Healthy City perspective on noise pollution terms. The issue of noise pollution will be linked to overtourism through the idea of it being one of the detrimental consequences of the latter phenomenon. Overcrowding is one of the main causes of a noisy environment, and tourism usually entails the coming together of many people. As a research-by-design project, the goal is to create a spatial plan applicable to a case study that suffers from noise pollution due to overtourism - in this case, the Turó de la Rovira[1] (see Fig.1 & 2) - to protect residents from sound pollution while preserving the attractiveness of the tourist site.

Figure 1

Site physical map

Note: By Google Earth. (June, 2023). [map of the Turó de la Rovira]. Retrieved June 5, 2024, from https://earth.google.com/web/@41.41933029,2.16311582,236.14078142a.
Each number coincides with the location of certain photographic figures in the paper.

[1] Meaning "The Rovira Hill" in reference to the hill in which the tourist site and the residential area are located.

Figure 2

Overtourism at different times

Note: Photographs of the Turó de la Rovira at 2 different occasions, April 2024. Own work.

Research question

This research aims to analyse the impact of noise pollution caused by overtourism and how it can be dealt with without hindering tourist attractiveness. Thus, the research questions are:

How can noise pollution emanating from tourist sites be minimised to avoid nuisance to adjacent residential areas without damaging the site's attractive features?

> *Sub question:* What are the effects of noise pollution on human well-being?
> *Sub question:* Which soundproofing strategies and infrastructures are available?
> *Sub question:* How can they be applied to open-space urban areas in a way that does not hinder the attractiveness of a tourist site?

Structure

Following a research-by-design approach, the development of the project involves three distinct phases: pre-design, design, and post-design. The first phase involves the coupling of research and design through the analysis of key concepts of the issue at hand, the local context and the study of possible design solutions, which ensures that the eventual design is responsive to the needs and aspirations of the chosen space and those using it. This part is especially present in the Theoretical Framework of the project. Then, during the design phase, research and design are interwoven through exploration, projection and re-evaluation of the resulting product(s). The process fosters an environment of experimentation and discovery that aims at unearthing innovative solutions to complex problems. Finally, the post-design phase is the presentation and assessment of the resulting product. This step requires a strategic way of communication that can be received by a targeted wide audience in a comprehensive and interesting form. In this part of the project, research and design are decoupled. This resulting product is visible in the Results and Conclusions sections, which also explain the ideation process behind the design phase (Roggema, 2016). In the end, the goal of the final research product is to create a critical inquiry on a general issue through a proposed plan for a specific and relevant location. In this sense, the chosen research-by-design methodology provides an exploratory arena that makes the topic analysis more pragmatic. Due to the short-term nature of this research, the design will not be validated and built on through a classical research-through-design approach in which local communities are involved in the design process, but rather through peer review (Hauberg, n.d.).

Theoretical framework

Popularised by the World Health Organization's Healthy City Initiative, the concept of 'Healthy City' has been a topic of analysis and practical application for some time. The concept is defined as a city that consistently improves physically and socially, while increasing community resources to facilitate mutual support among citizens, aiming for the development of their full potential (World Health Organization, n.d.). Although the basis of the original idea was mostly focused on the physical health of a city's residents, the concept has broadened to also encompass their social environments by amplifying the community resources available. Some scholars propose approaching the Healthy City model by focusing on empowering local communities with the necessary tools to avoid issues that may harm their well-being and physical health, as well as to promote beneficial practices regarding mobility, accessibility, social interaction, etc. (*Healthy City*, n.d.; Farquhar, 2001; Tulchinsky & Varavikova, 2014). In that sense, urban planning and space development are major instruments to avoid situations that may harm a city's health.

One of these detrimental phenomena is overtourism, which occurs when the residents of a destination feel that their quality of life is affected by tourists visiting their area of residence. The concept is not limited to mass tourism in the sense that the issue is not solely based on the number of visitors. In other words, the problem is not only the quantity of tourists, since a small group of people can also be potentially noisy, uncivil, and disrespectful. Mass tourism focuses solely on the negative externalities produced by an excessive amount of visitors, while overtourism goes beyond this purely numerical scope. According to Capocchi et al. (2019), there are three main parameters to the concept. These are tourism growth, tourism concentration, and tourism governance. The article's main conclusion is that the increase or decrease of the aforementioned parameters affects the impact of overtourism on a city's health. In academic terms, the word 'overtourism' and its definition are fairly new, even though the phenomenon in itself is not. It was first described - and later trademarked - by travelling website Skift back in 2016 to explain the surge in mass tourism in Iceland at the time (Ali, 2018).

As a fairly new concept, overtourism may sometimes lack consistency in terms of definition. According to Pasma (2022), this and other factors such as short-term orientation on economic priority, and conflict of interest between stakeholders have been identified by scholars as possible causes of a lack of a policy and spatial designs to overcome the issue. The latter cause is especially challenging, since some stakeholders have not even been identified and their neglect means a significant failure to address overtourism. One such group of stakeholders are visitors themselves, as well as policymakers and Destination Marketing Organizations (DMOs) (Pasma, 2022). Jaimeson & Jaimeson (2019) argue that, on account of the short-term orientation on economic priority, overtourism is a result of a tourism model driven by numbers rather than a sensible and informed policy approach. This relates to the disregard of residents and local communities as stakeholders in the process, among other set-aside factors (Jamieson & Jamieson, 2019).

Finally, Gretzel (2019) investigated how social media possesses an increasing influence over travel plans and tourism dynamics. They argue that social media has a persuasive power for sharing content, and travel-related information is especially attractive. In practical terms, this has meant a focus on destinations that are considered 'shareworthy'. This is relevant to this research's case study, as the site is suffering from overtourism because it has become trendy. In sum, social media increases motivations to travel - especially to specific destinations - and influences the behavioural patterns of visitors once they arrive (Gretzel, 2019).

One of the negative consequences of certain behavioural patterns in overtouristic sites is often noise, understood as "any sound which is unpleasant, unwanted or so loud that it causes (...) disturbance or irritation" (Gupta et al., 2018, p.1). Noise pollution is the same phenomenon when it is present in the environment (Zimmerman & Robson, 2011). Coping with noise comes with certain health costs. Even if humans can adapt to it to some extent, this adaptation depends on the person and it is rarely complete (Lercher, 2018). Due to the rapid urbanisation rate, there is an increasing focus on the dangers of noise pollution to the health of individuals. These dangers affect both physical and mental health and they can be categorised as auditory and non-auditory health effects. Noise-induced hearing loss is the main auditory consequence of noise pollution. Non-auditory health effects include cardiovascular disease, worsened cognitive performance, and sleep disturbance (Basner et al., 2014; Gupta et al., 2018; Utilities One, 2023). The usual way to handle this issue is to regulate noise through the definition of maximum levels of sound pressure level and, when noise surpasses this level, adopt mitigation measures (Asdrubali & D'Alessandro, 2018).

To tackle noise pollution in the chosen area, all strategies proposed follow a soundscape approach. The concept of soundscape was first introduced by Schafer in 1977, after observing that the acoustic aspects of space were often overlooked in favour of visual ones. His research focused on the human perception of environmental sounds. Thus, soundscape was proposed as a connector between humans, their activity, and their surroundings (Fusaro et al., 2016). The concept is related to acoustic ecology through natural and artificial sounds. In plain words, it is the acoustic equivalent of a landscape and it can be employed in different ways for multiple purposes (Rehan, 2016). To analyse and manage urban soundscapes, sounds are categorised according to their origin: geophony, biophony, and antropophony depending on whether they come from abiotic, biological, or human sources (Patón Domínguez et al., 2020). These, in turn, can be recognised as wanted or unwanted sounds depending on the context. These categorisations produce three main approaches to soundscape in urban planning: the introduction of wanted sounds, the localisation of functions, and the reduction of unwanted sounds (Soundscape Design, 2019).

Case studies

Introduction of wanted sounds

The first approach can be done through the direct incorporation of new sounds or by the stimulation of existing ones. The most common way to do so is by focusing on natural sounds such as vegetation, fauna, or water. Of these three, the most popular option is auditory masking through water infrastructure (Soundscape Design, 2019). Using this geophonic sound to mask noise pollution can be done differently depending on the chosen infrastructure. One of the best examples of auditory masking through water is the construction of a waterfall in Paley Park, New York (see Fig.3). This small park surrounded by high buildings and bombarded by traffic noise was converted into an urban oasis thanks - among other elements such as vegetation - to its artificial waterfall, which creates white noise that muffles other sounds (Rehan, 2016). Other applications include fountains, such as the one on the rooftop of San Francisco's Salesforce Transit Center, known as "The Bus Fountain" (see Fig.4). This 305 metres long water statue is designed to mask the sound of buses passing through the floor below it by being animated by those same buses (Ned Kahn Studios, 2022; Soundscape Design, n.d.).

Figure 3

Paley Park, New York

Note: By Project for Public Spaces. (2022). *Paley Park*. https://www.pps.org/places/paley-park

Figure 4

Bus Fountain, San Francisco

Note: By Ned Kahn Studios. (2022). *Bus Fountain*. https://nedkahn.com/portfolio/bus-fountain

Localisation of functions

This approach is mainly concerned with sound compatibility regarding time and space. This can entail a variety of strategies that may go from sound compensation through noise ordinance laws or relocation of functions, to the embracement of wanted or even unwanted sounds (Soundscape Design, 2019). One example in Barcelona of a relocation of functions is the ring road project of 1992 (see Fig.5). This development that is commonly found in many other Western cities as a way of balancing traffic and free spaces in a metropolis was part of a bigger pre-Olympic Games effort to improve Barcelona. In practical terms for noise pollution, this semi-buried ring road surrounding the city diverts a big share of the traffic going through Barcelona, thus reducing the overall noise pollution in the city. Moreover, the fact that it is semi-buried also means that it is not as noisy in the areas surrounding the ring road (Ajuntament de Barcelona, 2019).

Figure 5

Aerial view of the ring road

Note: By Ajuntament de Barcelona. (n.d.). *Ronda de Dalt*. Servei D'informació D'obres. https://ajuntament.barcelona.cat/obres/en/ronda-de-dalt#galeria-msonry-161-all-4

Reduction of unwanted noise

The final approach to soundscaping can be done through sound barriers, topographical modifications, and/or the application of acoustically appropriate materials (Soundscape Design, 2019). For the first strategy, several companies specialise in the production and installation of noise barriers. One of them, All Noise Control (2022), describes them as physical structures expressly designed to lessen the impact of noise pollution by absorbing, reflecting, or diffracting sound waves, depending on the chosen material. They custom manufacture a wide range of noise barriers and other high-performance soundproofing products for industrial, commercial, and even institutional markets. One such case made by All Noise Control for an Alabama industrial mining company required the production and installation of sound-absorbing outdoor curtain acoustic blankets that were UV resistant and promised maximum durability, which complied with the needs and requirements of the customer. Outdoor acoustic blankets are a type of soundproofing technology that is widely used in the mining industry in long-term constructions or even permanent applications (All Noise Control, 2022). Another case that would be more fitting aesthetically speaking is the acoustic barriers near the Porte d'Ivry station in Paris. These muffle the noise of the tram station and the nearby highway, which is the most common use for noise barriers (see Fig.6) (WebUrbanist, 2016).

Figure 6

Acoustic barrier near the Porte d'Ivry station, Paris

Note: By WebUrbanist. (2016, July 10). Mufflers: 10 Artistic Acoustic Highway Noise Barriers. *WebUrbanist - Urban Art, Architecture, Design & Built Environments*. https://weburbanist.com/2015/03/22/mufflers-10-artistic-acoustic-highway-noise-barriers/3/

Complementing this first main layer of soundproofing infrastructure, a strategic landscape strategy through the planned addition of vegetation as a cityscape element can also be an added source of quietness, as well as a beautification tool for the barrier. Other than the obvious main effect as an instrument for noise reduction, the added greenery of strategic landscape improves air quality, creates new habitats for local species, and regulates temperature (Utilities One, 2023). On its own, a great example of the use of vegetation for noise reduction is Frankfurt Airport's green roof system (see Fig.7). Being the largest airport in Europe, having an extensive green roof network was crucial to improving air quality, regulating temperature and reducing noise pollution (Soundscape Design, n.d.-a; *Frankfurt International Airport (FRA)*, 2018).

As a combined strategy, a good case study of a green noise barrier is the Forest Corridor design for Hong Kong (see Fig.8). This highway noise barrier was developed for the 2009 Open International Competition for Noise Barrier/Enclosure organised by the Hong Kong Government, where it came in second. The design took into account aesthetics, functionality, and, most importantly, effectiveness (Furuto, 2022). Another popular case with a different approach in terms of barriers are the ground ridges near Schiphol airport (see Fig.9 & 10). These wedge-shaped hills covered in grass are designed at a specific angle to deflect sound waves upwards, thus protecting the neighbourhoods surrounding the fourth busiest airport in Europe (Schiphol, n.d.).

Figure 7

Frankfurt Airport's green roof system

Note: By Ljud-Admin. (2020, February 21). Frankfurt Airport's green roof system. Ljudplanering. https://soundscapedesign.info/2019/11/12/3198/

Figure 8

Forest Corridor highway noise barrier, Hong Kong

Note: By Furuto, A. (2022, August 24). *Forest Corridor – Highway Noise Barrier / BREAD Studio*. ArchDaily. https://www.archdaily.com/278342/forest-corridor-highway-noise-barrier-bread-studio

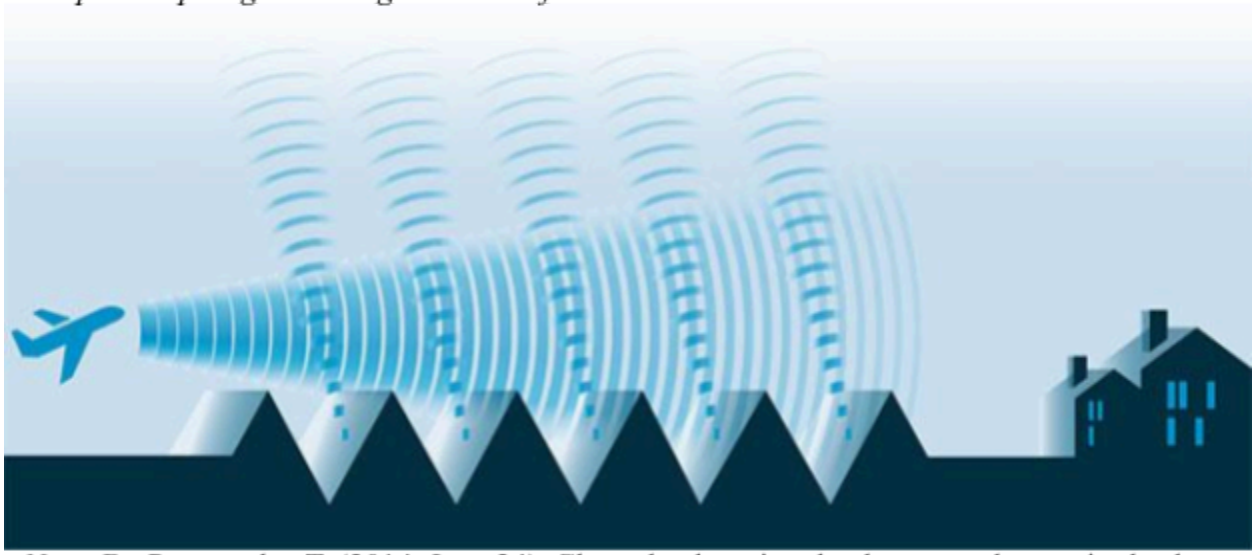
Figure 9

Schiphol Airport's ground ridges

Note: By Schiphol. (n.d.-b). Landscape Design Plan to combat noise nuisance. https://www.schiphol.nl/en/schiphol-as-a-neighbour/page/landscape-design-plan-to-combat-noise-nuisance/

Figure 10

Schiphol airport ground ridges sound deflection



Note: By Porostocky, T. (2014, June 24). Clever landscaping that bounces plane noise back into the sky. WIRED. https://www.wired.com/2014/06/airport-schiphol/

Case study: Turó de la Rovira

The chosen area of analysis is the Turó de la Rovira, a hill situated in the northern part of Barcelona, close to other tourist attractions such as the Parc Güell (see Fig.11). The specific space of touristic significance is popularly known as 'Bunkers del Carmel'. These old anti-aircraft batteries dating from the Spanish Civil War (1936-1939) (see Fig.12) have been getting increasing public attention. As explained on the website *Els Bunkers Del Carmel* (n.d.), their original goal was to protect the city from fascist Italian aviation during the bombings that Barcelona suffered in the war. Once the conflict ended, the batteries were disabled, but not retired. During the following decades, thousands of Spanish migrants who arrived in the city from other regions of the country to earn a living created slums to live in. The abandoned area of the Turó de la Rovira was a perfect site for such development, and the neighbourhood came to be known as '*Los Cañones*'[2]. After some social unrest because of the inhuman conditions of the residents of such shanty towns that began in the 1960s and ended in the 1990s, the slums were demolished and new accommodations were built on the hill (*Els Bunkers Del Carmel*, n.d.). This development was due to the impending arrival of the Olympic Games in the city, which also meant the start of a new era of tourism for Barcelona.

Figure 11

Turó de la Rovira location (commonly known as 'Bunkers del Carmel')

Note: By Google Maps. (n.d.). [map of Barcelona]. Retrieved April 24th, 2024, from https://maps.app.goo.gl/ZphXRrGjsQYguZg67

[2] Meaning "The Canyons" in reference to the anti-aircraft batteries

Figure 12

La bateria antiaèria (anti-aircraft battery)

Note: By *Bateria antiaèria*. (n.d.). Bunkers. http://www.bunkers.cat/ca/history

Nearly 30 years later, after the COVID-19 pandemic came and went, tourism rates went down and up again. Broadly speaking, this meant that once the pandemic-imposed restrictions ended, millions of visitors returned. This caused tourist locations all over Europe to implement certain regulatory strategies, such as fines, entrance fees, and time slots. In Venice and Athens, for instance, they created a time-slot system to enter the historical centre and the Acropolis - respectively - requiring visitors to register in advance and pay an entrance fee (Florian, 2023). In Barcelona, such regulations have already been put in place in other tourist sites such as the Sagrada Familia Basilica or the Parc Güell. The latter example is more similar to the case study at hand, as it is an outdoor space that comprises a natural environment, landscape views, and areas of historical and cultural significance. The park applies a time-slot system that includes norms of conduct to protect the heritage value of the site, entry requirements, and penalties for noncompliance with such regulations (*Normativa D'accés*, n.d.). Having an example of the implementation of entry regulations of a similar tourist site to our case study in the same city provides the necessary information on implementation requirements, possible setbacks and issues with the surrounding neighbourhoods, as well as its overall success rate in reducing overcrowding and overtourism. However, the city council does not want to implement this same strategy on the Turó de la Rovira, as they consider it to be a public space that should remain open to the neighbours (Gutiérrez, 2023). Instead, from May 2nd 2023, the city council decided to close the site at night with metal fences (see Fig.13) to let the neighbours rest at night, with no success (Palmer, 2023). There have been numerous break-ins at night that have resulted in noise pollution, littering, vandalism, and even instances of group aggression (Línia Horta, 2023). Therefore, there is a need for alternative proposals on how to address the issue.

Figure 13

New closing fences

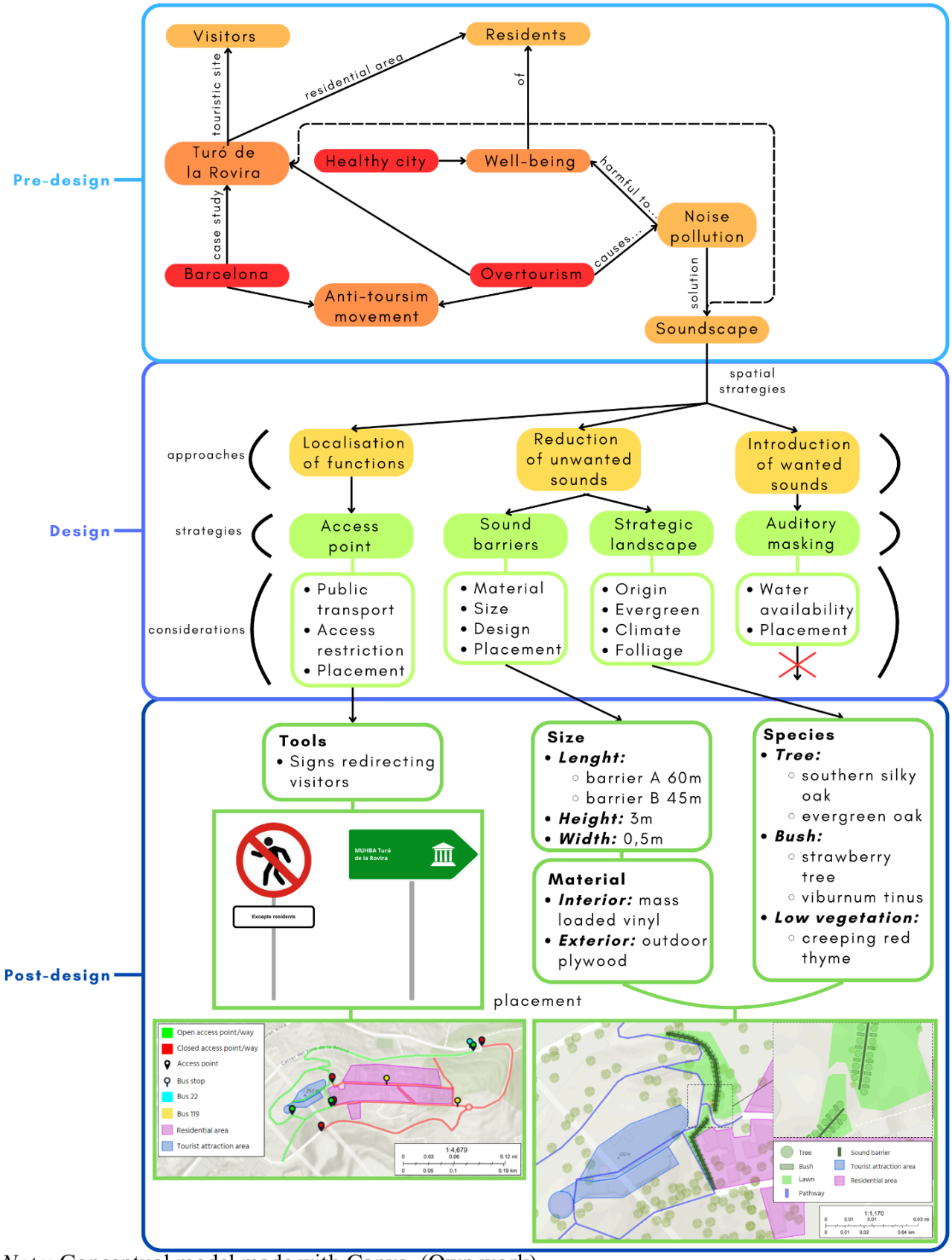
Note: Photograph of one of the entrances to the site. Own work.

Conceptual model

To get a visual understanding of the connections between the aforementioned concepts, a conceptual model was created (see Fig.14). This outline highlights the aforementioned overarching structure of the research by providing a visual representation of the key concepts and their interrelationships and dividing them into the three phases of the project. The pre-design phase consists of the three main concepts of the project - Healthy City, overtourism, and Barcelona as the chosen case study- and it connects them through their conceptual development into more specific notions such as well-being, noise pollution and the Turó de la Rovira. Broadly speaking, this outline follows a general-to-concrete pattern showcased through a colour scheme. Following this model, the design phase moves away from the theoretical concepts and exposes the ideation process through the three approaches to soundscape, their resulting strategies, and the considerations that should be taken into account for each of them. Finally, the post-design phase showcases the chosen spatial strategies and delves into the design specifications for each of them. The conceptual framework was created by the author using Canva.

Figure 14:

Conceptual model



Note: Conceptual model made with Canva. (Own work)

Methodology

This project follows a research-by-design approach as its main methodological procedure. As described by Barnett (2000), traditional model design outcomes are predetermined by a set of objectives beforehand, which can limit creativity and flexibility in the design process. The chosen model in this research, however, understands design as a form of dynamic research, starting with a research question, following an adapted methodology and presenting the resulting idea in an informative manner, not based on its actual implementation and performance (Barnett, 2000). In terms of data collection, there is secondary data in the form of analysing key concepts and case studies in the Theoretical Framework section. The key concepts are highlighted in the conceptual model and provide contextual data, while the case studies were analysed during the design phase of the project as inspiration for the final design proposal. There is also primary data in the form of soundmaps and images -whose location is specified on Figure 1 - relevant to the development of the final design. Overall, the design section utilises all this information to examine three approaches to soundscaping as a model to minimise noise pollution.

Data collection

For the spatial analysis before the development of the design, two soundmaps were made using the Noise Capture app for Android through the author's mobile phone (see Fig.15). The recordings for the noise maps were done on the 11th and 16th of April of 2024 with warm and sunny weather conditions in both of them. The first recording was done on a Thursday morning between 10:45 and 10:55. The noises on that occasion came from 8-10 groups of about 2-10 individuals each. The main languages heard at that time were English and German and 2 different groups were playing loud music on speakers. The second recording was done on a Tuesday between 15:40 and 15:55. There were 10-15 smaller groups of visitors (between 2-6 individuals each) and a street vendor present during the recording. In that instance, the main languages heard were English, Spanish, and Russian and there was no loud music being played. The identification of the aforementioned languages was possible thanks to the author's domain of two of them, the learning of a third, and the familiarity of the sounds of the fourth - German, from the first observation - thanks to a close relative speaking it fluently. This language analysis is relevant in determining whether the visitors were residents or tourists, thus establishing whether noise pollution in the area is an issue related to tourism or not.

In the end, the sound analysis and observation procedures have been useful in specifying the type of noise that the proposed spatial strategies will be facing, which is necessary information when deciding on certain design specifications. Furthermore, it reiterates the urgency for a solution and the noise pollution's relation with tourism as, in both instances, most of the noise was coming from foreign visitors and the level of decibels recorded in both cases was significant enough to be an inconvenience to residents. This latter statement is even more noteworthy taking into account that the dates of the recordings did not coincide with any major holidays or festivities and they were both weekdays in the morning and early afternoon, respectively.

Limitations

The chosen dates and data gathering method are not ideal, as it would be better to collect data on different months of the year, taking into account tourism seasonality. Moreover, illegal parties and break-ins at night account for much of the noise, and this data could not be gathered, as the project's schedule does not permit such an approach. It must also be mentioned that the city council does indeed have an Acoustic Quality map of the municipality. It is, however, too broad and does not account for specific spikes in noise pollution. It focuses more on traffic noise, which is not accounted for in this project, since it is not the main source of noise pollution in the area (Ajuntament de Barcelona, n.d.).

Figure 15

Soundmaps

Thursday, 11/04/2024 at **10:45-10:55** Tuesday, 16/04/2024 at **15:40-15:55**

Note: Soundmaps from 2 different occasions with a legend on the level of noise in decibels. Own work.

Results

This project analyses three spatial strategies that aim to protect the residential area surrounding the anti aircraft batteries from the noise pollution emanating from them without hindering the site's attractiveness. To do so, it follows a soundscape framework categorised into three distinct approaches: introduction of wanted sounds, localisation of functions, and the reduction of unwanted sounds. This specific framework was chosen after analysing the soundmaps generated during the data collection process, as it focuses on human perception of environmental sounds. This holistic perspective was deemed more adaptable to the variety of antropophonic sounds recorded. In the end, only two of the three approaches were deemed suitable for the design proposal. From these two approaches, three complementary strategies were developed.

Approaches

Introduction of wanted sounds

The analysed strategy and subsequent case studies for the incorporation or stimulation of pleasant sounds are very efficient and good practices for a wide variety of cases. However, although water infrastructures are very flexible in terms of implementation and have been proven effective, they are not an option for the Turó de la Rovira, since the region is going through a drought emergency, which is becoming increasingly common in the city (Burgen, 2024; Llach, 2024). Nonetheless, other pleasant sounds like the rustling of leaves will be a casual consequence of the strategic landscape strategy in the final design as part of the reducing unwanted noise approach.

Localisation of functions

The practical application of this approach focuses on the strategic localisation of sensitive functions. This has entailed the development of an access point restriction strategy. This strategy was partly inspired by the ring road project in Barcelona in terms of compartmentalisation of functions regarding mobility. In this project, however, the focus is on the flow of people and not of vehicles and the resulting design does not entail any infrastructural modifications on the roads. Nevertheless, it does imply a redirection of visitors to the site to avoid it becoming a nuisance to the residents.

Reduction of unwanted noise

The project has chosen this approach in its final design proposal through the combination of two complementary strategies: sound barriers and strategic landscape through vegetation. These are most fitting to the type of low frequency antropophonic noise coming from the site, as observed and analysed during the audio recordings for the soundmaps. This auditory characteristic is the reason why the sound absorbing outdoor curtains used in the Alabama mining case and the noise barriers of the Point d'Ivry in Paris are not best suited for the site. Nonetheless, the focus on materials from the latter, and the attention to aesthetics from the former cases were useful considerations in the final design.

In terms of greenery, the application of green roofs as seen in the Frankfurt airport project is not feasible in this case, since they would have to be placed in the residential area, which would entail a different perspective, since it would be a private property matter. Moreover, the overall goal and context are different in terms of the type of sound and stakeholders' needs. Nonetheless, both the Frankfurt and the Schiphol airports cases brought into light the importance of low vegetation in terms of sound absorption, which inspired the final design's greenery at all height levels. Furthermore, the latter project, and the Hong Kong case inspired the combination of both strategies, although the exact characteristics of the Hong Kong project could not be replicated in this case study, since the highway barriers were designed to be hanging from an elevated platform and the site does not have the necessary topographical conditions to do so.

Final design

In the end, the final design comprises the installation of sound barriers complemented by a layer of vegetation and the modification of the access points to the site. The advantage of this strategy combination as compared with the current curfew strategy explained on page 16 is that it does not limit the activities done at either space. This design does not rely on people's respect for the strategy, but rather it works regardless of it. Therefore, the current break-in issues faced by the curfew policy would not be a problem in this proposal, since residents would not be bothered by the noise on site (Gutiérrez, 2023). Moreover, their placement will not hinder the view from the site or the residential area, which complies with the design's goal of maintaining the attractiveness of the tourist site.

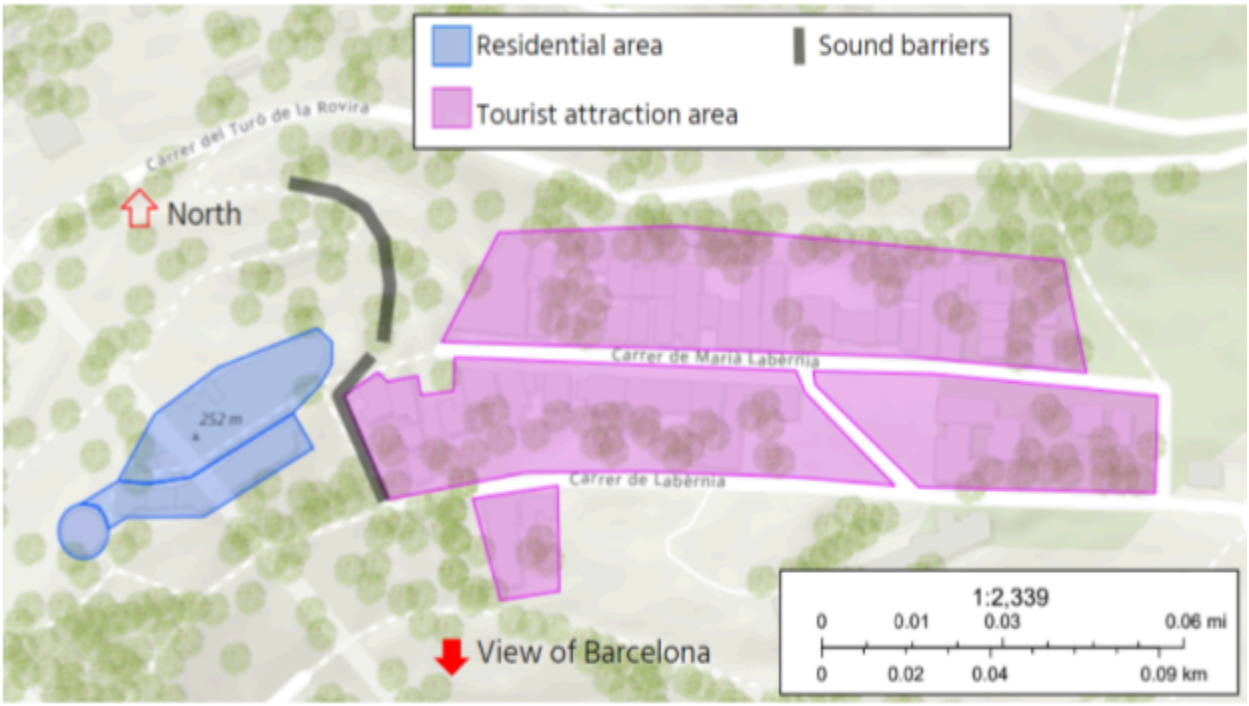
Noise barriers

Besides noise reduction, the sound barriers would add a layer of privacy to the neighbourhood as a sort of separation between both areas. Moreover, they have the potential to become urban landscape elements suitable for community art projects. Other possibilities like creating a green wall or a climbing area have been deemed unsuitable due to the risk of visitors trespassing into the residential area, which would defeat the design's purpose. Regarding the actual design specifications, the sound barriers would be located on the limiting area that divides the tourist site from the residential area (see Fig.16). The advantage of this location choice is that it would not be detrimental to the view of the city from the bunkers or the residential area, since they are both parallel to each other and facing the view. Thus, the tourist attractiveness of the site would not be damaged. Concerning its material, the barriers would be made of three distinct layers: two plywood outer layers and an inner mass-loaded vinyl one (MLV). The benefit of choosing MLV is that, since it is essentially a heavy yet flexible vinyl sheet, it can reduce more vibrations than other rigid materials like concrete or steel. Moreover, it is cost-effective, easy to install, and outdoor-proof and it is especially effective when combined with plywood. Besides this immediate benefit of the combination of both materials, plywood is also more aesthetically pleasing, it is weather resistant, and it can be a good medium for local artists to express

themselves through graffiti (Beaver, 2024; Legros, 2024). Its size in terms of length has been determined by the topographic characteristics of the area. Thus, the northern barrier would be 60m long, while the southern one would be 45m. Its width would be 0,5m, taking into account the average width of each material. Finally, its height would be 3m to provide more privacy to the neighbours (see Fig.17).

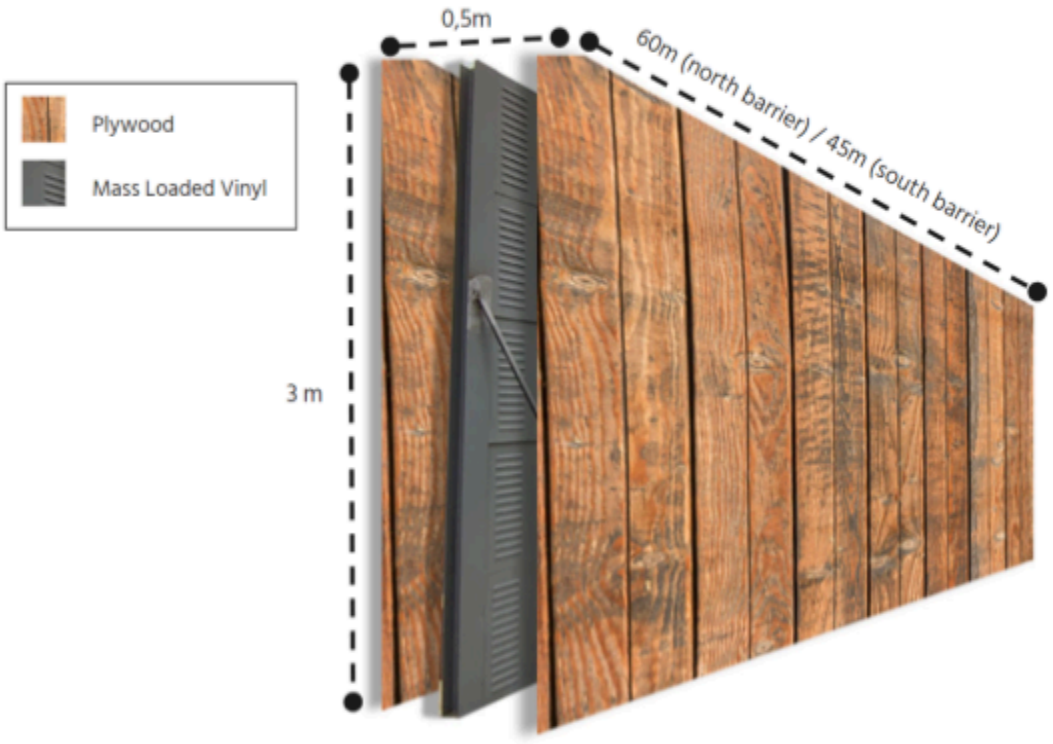
Figure 16

Sound barrier location map



Note: ArcGIS map on the location of the sound barriers, as well as the touristic and residential areas. Own work.

Figure 17
Sound barrier design



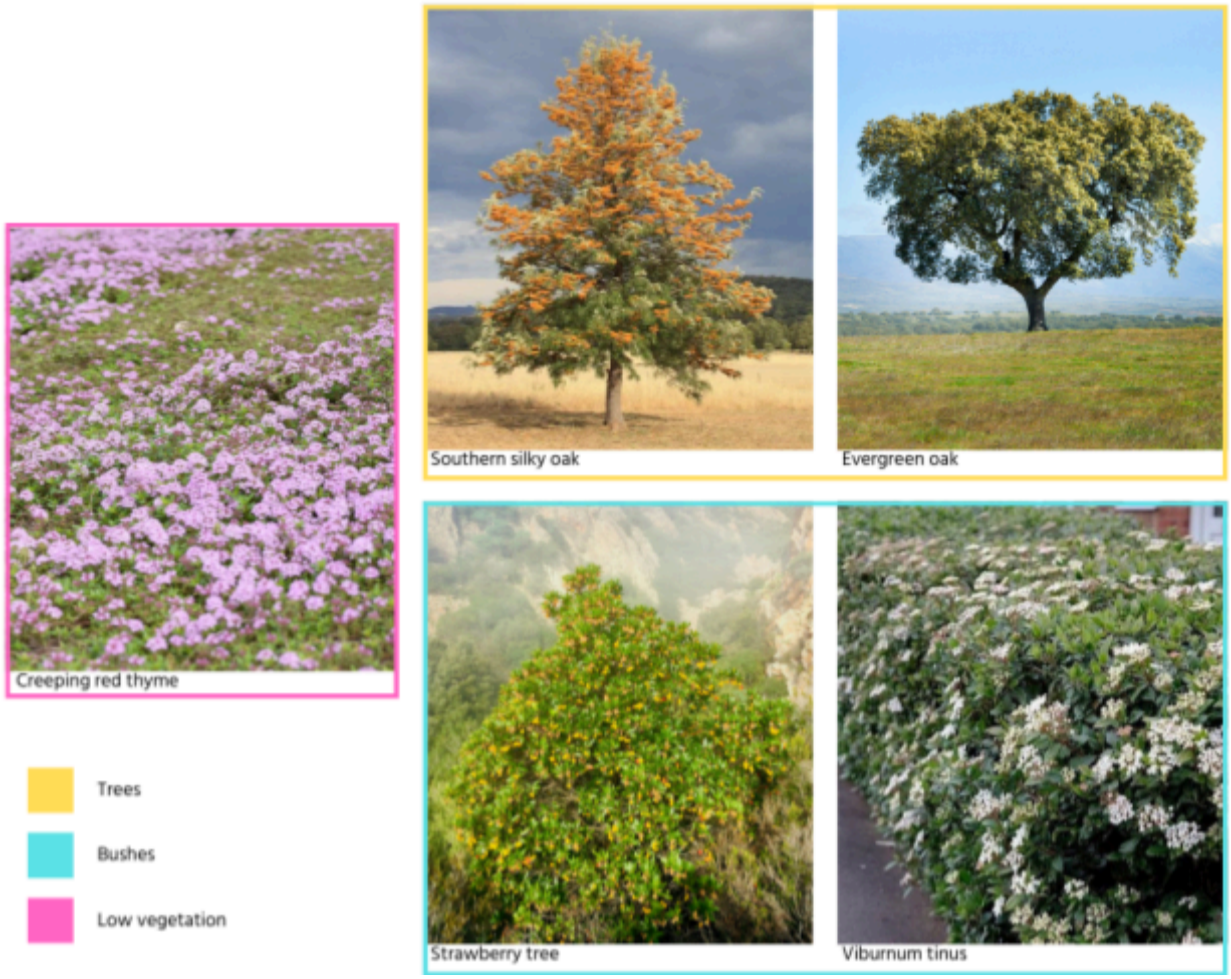
Note: Photoshop representation of sound barrier size and material composition. Own work.

Strategic landscape

In regards to vegetation, it was important to choose plants that could withstand the local climate. Moreover, in terms of sound muffling, choosing evergreen plants at different heights and with different types of leaves meant complete, year-round noise protection (University of Washington, n.d.). Consequently, two trees, two bushes and one low vegetation species were chosen - four of which are native to the area (see Fig.18). For trees, southern silky oaks and evergreen oaks will be alternated. They are both evergreen tree species that thrive in Barcelona's climatic conditions (Torrella, 2024; Betevé, 2020). In between the row of trees, there will be two alternating species of bushes: strawberry trees and viburnum tinus. These species are known for their benefits to biodiversity, especially for pollinating insects (Torrella, 2023). Finally, the chosen lawn species is creeping red thyme, known for being drought-tolerant and low-maintenance (Vinje, 2023). In the final design, trees will be separated by 3m of each other with a bush in between them - 1,5m away from each tree - to ensure the proper growth of all vegetation (see Fig.19, 20 & 21) (Woodland Trust, n.d.). They will also be separated by 1m from the barrier.

Figure 18

Vegetation species



Note: Visual representation of the chosen vegetation species. Own work.

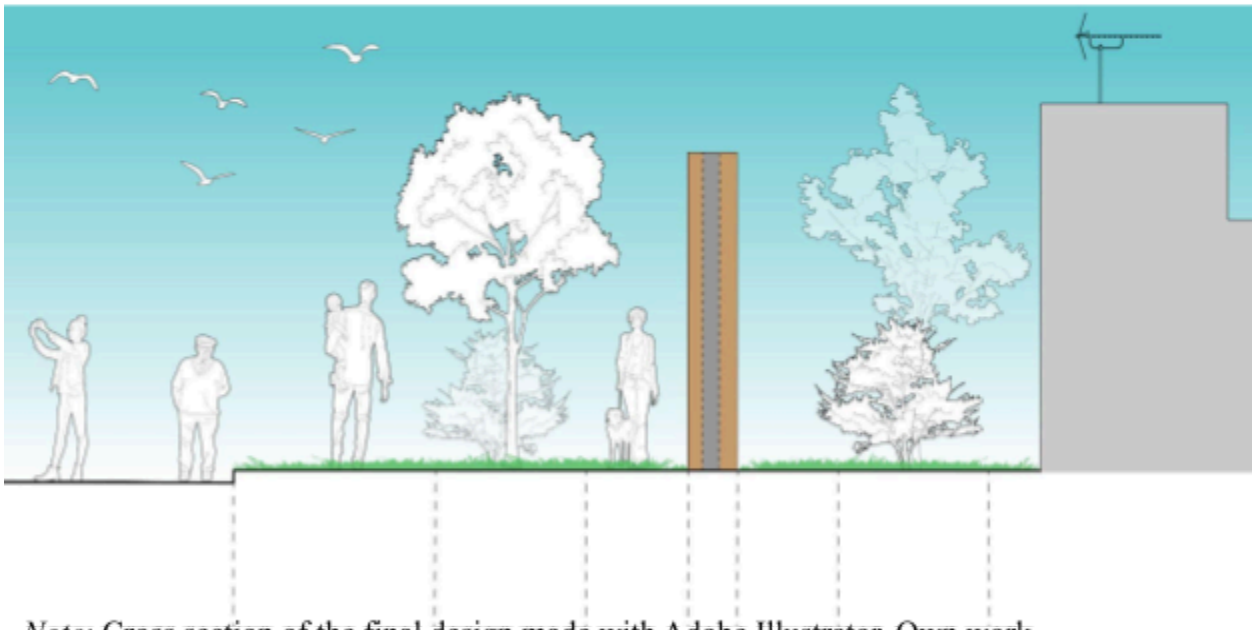
Figure 19

Final design map

Note: ArcGIS map of the final design. Own work.

Figure 20

Design cross section



Note: Cross section of the final design made with Adobe Illustrator. Own work.

Figure 21

Street view representation of the final design

Note: Street view interpretation of the final design on site made with Photoshop. Own work.

Access point modification

The reasoning behind this idea is that part of the noise pollution issue comes from visitors going through the residential area to access the site. Luckily, there are several ways of accessing the tourist area. Some of them go through the adjacent neighbourhood, while others go up the hill from the western side (see Fig.22). The overall idea behind this proposal is to restrict the access of visitors to the ways that go through the residential area, and instead direct them to those going on the other side of the hill (see Fig.23). The modes of transportation used by visitors to get to the area have also been taken into consideration in this design. Two buses are going through the area. The first one, number 22, comes directly from the city centre and has its final stop right next to the tourist site. The second one, number 119, is a small neighbourhood bus commonly used in the steepest areas of the city to ease residents' daily mobility. The idea would be to redirect visitors through signs placed in the roundabout where bus 22 has its final stop, as well as other restricted and permitted access points as seen in Figure 22. These signs would either specify which access points are exclusive to residents or direct visitors to alternative access points to the site (see Fig. 24). Unfortunately, the signs may not always work on visitors that are familiar with the site. Nonetheless, it is expected to redirect most of the inflow of visitors.

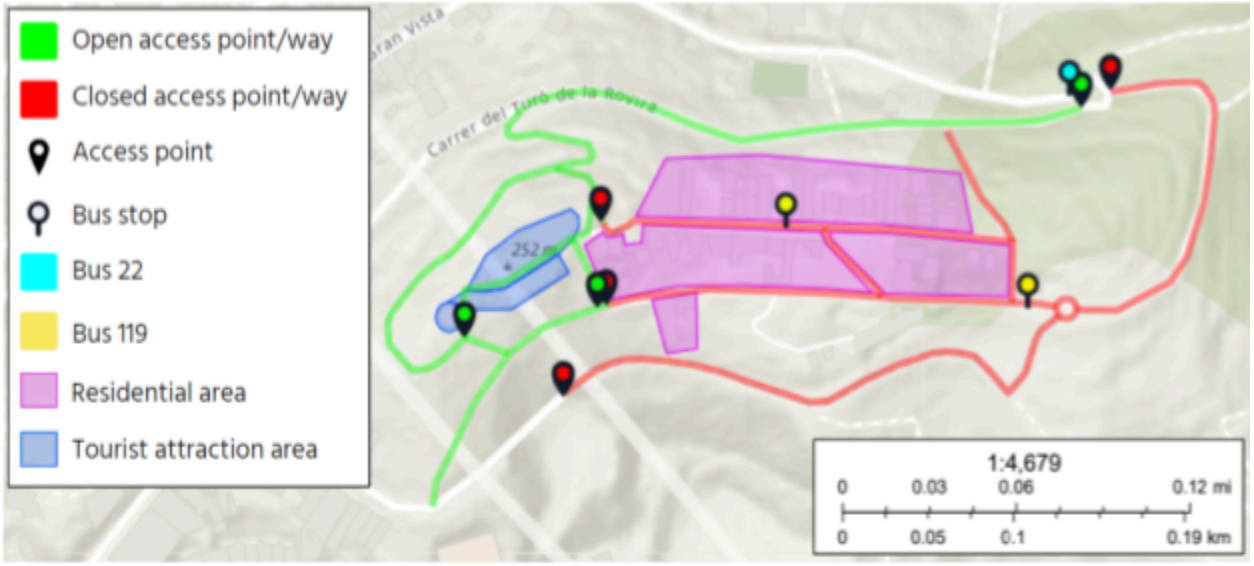
Figure 22

Residential and hillside access points

Note: Photographs of access points going through a residential area (left) and through a hillside (right). Own work.

Figure 23

Access point design map



Note: ArcGIS map on modifications in the access points to the touristic site. Own work.

Figure 24

Access signs

Note: Google Maps. (2022). [view of Carrer de la Gran Vista]. Retrieved June11th, 2024, from https://maps.app.goo.gl/PBkjWEKxmdmvrK2D6

Ethical considerations

The author's link with the city, as someone born and raised in Barcelona - although not in the chosen neighbourhood -has been an asset in terms of language and background knowledge. However, it has also been a source of bias at times regarding her opinion on the city's current tourism management. This bias has been dealt with to the best of the author's ability by verifying information through multiple sources, checking for alternative explanations, and, most importantly, acknowledging the risk of bias in itself.

Conclusion

This research-by-design project aimed to find a design solution for noise pollution caused by overtouristic sites and its relation with the health of the urban environment surrounding it. Following this line of thought, the final design had to minimise the impact of noise pollution on residents while not damaging the attractiveness of the tourist site. To develop this plan, the chosen case study was the Turó de la Rovira, in Barcelona. This recently trendy historical space at the top of one of Barcelona's hills was chosen because of the conflicting relationship with its adjacent neighbourhood as a result of vandalism and noise complaints from the local residents.

After analysing the negative effects of noise pollution on human health, the social, historical, and topographical context of the site, and the soundproofing strategies available to apply in open spaces, one methodological concept and three approaches were analysed. The main concept behind the design process was soundscape. Following this idea when planning in cities entails three possible approaches: localisation of functions, introduction of wanted sounds, and reduction of unwanted sounds. The first approach meant the development of an auditory masking strategy through water infrastructure. Although this strategy was highly flexible and effective in its application, it was not possible to carry out, since Barcelona is suffering from increasingly frequent and severe droughts. Thus, the final design followed the other two approaches. The first one meant the creation of an access modification strategy for the site to avoid visitors entering the site through the residential area. Instead, the plan was to redirect them through alternative ways that did not bother neighbours by using signs. The final approach combined two spatial strategies: sound barriers and strategic landscape through vegetation. After analysing the most prevalent applications of both strategies, a mix of MLV and plywood was chosen for the sound barriers in combination with an alternating row of different types and species of vegetation on either side to maximise effectiveness, as well as to benefit biodiversity and regulate temperature.

Broadly speaking, the site's analysis, as well as the design proposal derived from it may be useful to other researchers and urban planners working on this same area or topic. Although the project does not include the actual implementation of the design, it sheds light on an existing issue faced by many touristic European cities, as well as proposing a potential solution. Ultimately, the paper may even open new branches of discussion in academic and institutional circles, hopefully including residents and local organisations for a change.

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