BEYOND MADRID'S HEAT

Sheltering the Vulnerable

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RESEARCH PAPER

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[FRONT COVER]
Shanty town in the Villaverde district, near San Cristóbal de los Ángeles

[FIGURE 1]
Fascination with (energy) systems applied to facade as retrofitted. In this photo we can see gas pipes, drainage pipes. A central heating boiler on the balcony. A air-conditioning unit atached to the facade. Shading devices. Ventilation ducts. Photo by Author taken during the fieldtrip to Madrid in November 2024

PREFACE

This research originates from a curiosity about the complexities of sustainability in the built environment and an understanding of what it truly means for architecture to be sustainable. Throughout my studies, I have become increasingly fascinated by the intersection of architecture with other disciplines, leading me to explore a diverse range of disciplines. Between my studies, I worked as an energy performance consultant, where I analyzed the energy efficiency of residential buildings throughout the Netherlands. It was through this role that I began to view sustainability mainly in terms of the built environment's physical and technical dimensions. However, this approach, while very valuable, was one-dimensional. I have come to realize that sustainability is not merely a question of technical optimization or energy performance, it is a multi-dimensional challenge that extends beyond mere efficiency.

This project is both an attempt to grasp the full complexity of sustainability and a reflection on the evolving role of architecture in addressing the pressing challenges of our time. It is an attempt to grasp the full complexity of sustainability, and what it entails to make something truly sustainable.

Climate justice
Climate shelters
Informal settlements
Social equity
Urban Heat Island

ABSTRACT

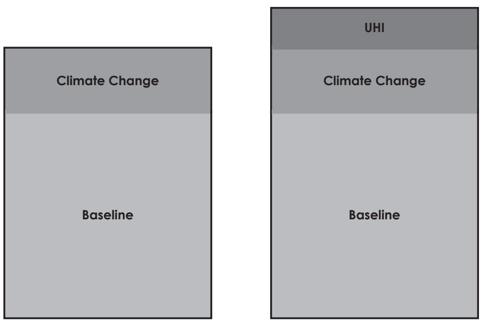
During the summer months, Madrid endures extreme heat. These high temperatures strain both the infrastructure supporting the city and the well-being of its inhabitants, disproportionately impacting marginalized populations. Marginalized populations such as the homeless population and inhabitants of “Poblados dirigidos” face heightened risks due to inadequate shelter and limited access to cooling infrastructure. While previous research has addressed the technical dimensions of urban heat mitigation, there is a lack of focus on the socio-spatial inequalities of vulnerable populations regarding urban heat. To address this, the research combines quantitative analysis with qualitative fieldwork. San Cristóbal de los Ángeles was selected as the intervention site due to its socio-economic challenges, historical context, and observed urban heat vulnerabilities. The findings show that the impacts of urban heat are rooted in existing social, historical, and spatial inequalities. Responses include the development of climate shelters that offer relief from extreme heat, as well as its establishment in a broader network that ensures spatial distribution, accessibility, and integration within the city’s existing infrastructure. This study highlights the need to rethink the role of shelter in responding to overheating cities. Addressing Madrid’s urban heat is not solely about reducing temperatures, it is about rethinking the socio-spatial systems that shape its city, ensuring they are inclusive, resilient, and just.

INTRODUCTION

In the current era of rapid global change, humanity faces challenges and opportunities. Technological advancements continue to reshape our daily lives, while climate change alters the very environment in which we live. Historically, human survival has relied on our ability to adapt, yet this capacity is unevenly distributed among different populations. Those who are less fortunate often face greater barriers in responding to these shifting realities. As we navigate this transition, how can we ensure that adaptation strategies are inclusive, equitable, and considerate of those most at risk?

Climate change is not just an environmental crisis, it is also a social crisis that deepens existing inequalities. In many urban settings, daily routines are increasingly influenced by changing climatic conditions. The city of Madrid demonstrates this reality. In the case of Madrid, the effects of climate change become more noticeable each year, with rising temperatures and increasingly unbearable heat during the summer months. While some demographics are better equipped to handle these changes, others are not. Marginalized populations find themselves on the front lines of climate-related challenges, facing both physical and mental impacts in the form of heightened health-related risks and increased social isolation.

Madrid's vulnerability to extreme heat is heightened by the Urban Heat Island (UHI) effect, a phenomenon where urban areas retain significantly more heat than their rural surroundings *(Figure 2)*. This effect, driven by dense urban development, anthropogenic activities, and increased energy consumption, has resulted in temperature differences of up to 8.5 degrees between the city center and its rural surroundings *(Arup, 2023)*. Historically, Madrid's climate has been characterized by hot dry summers, but urbanization has amplified the severity of summer heat *(Moreno et al., 2020)*. Today, Madrid ranks among the most extreme urban heat hotspots globally, with significant implications for public health, infrastructure, and social equity.



*[FIGURE 2]
Differences in temperature between urbanized and rural areas including the Urban Heat Island (UHI) effect by the Cooling Singapore project (NUSEnterprise, 2022)*

The main question that this research paper will address is:

“How can **localized architectural interventions** and **urban infrastructure** address the **vulnerabilities** of **marginalized populations** in response to **Madrid’s Urban Heat**?”

Chapter 1, *“Vulnerabilities”*, provides an examination of the various factors contributing to the vulnerabilities regarding urban heat. During the field research trips to Madrid, the struggles faced by the city’s marginalized populations became more clear. Prior to the visits, six neighborhoods were identified to house higher proportions of marginalized populations. In and around these neighborhoods a demographic was located that was not found in any database: the homeless population of Madrid. This population endures exposure to extreme heat in summer and harsh cold in winter, without adequate shelter or resources. The area with the highest concentration of homeless individuals and the most vulnerabilities related to urban heat, was located in the southern periphery of the city in the neighborhood San Cristobal de Los Angeles. This area is known for its cultural diversity and has the lowest per capita income in the city. The presence of homeless people, drug users, and sex workers also demonstrates the area’s socio-economic challenges, making it a potential site for inclusive interventions.

The second chapter, *“Seeking Shelter”*, addresses the spatial, social, and infrastructural dimensions of climate adaptation, with a particular focus on the role of climate shelters as a response. Climate shelters could provide vital relief for vulnerable populations during extreme weather events. Furthermore, this study is framed around the principles of climate justice, specifically the pillars of recognitional, procedural, and distributive justice *(Mohtat & Khirfan, 2021)*. By looking at urban heat as a lens to address inequities, this research aims to move beyond merely mitigating urban heat, but instead designing more inclusive and resilient communities.

The final chapter, *“Shifting the Balance”*, explores the physical dimensions of urban heat, focusing on how its perception as a threat can be shifted to reveal its possible beneficial potentials. This includes a section on mitigation strategies and another on opportunities for reusing urban excess heat.

While several research methods were proposed in the initial Research Plan, not all are explicitly represented in this research report, as some were primarily used during the design phase. Since these methods fall outside the scope of this report, their applications can be found in the appendix.

01.
VULNERABILITIES

As cities continue to experience rising temperatures due to climate change and the Urban Heat Island (UHI) effect, certain groups are disproportionately affected by heat stress and its associated health risks. The severity of this issue is exemplified by cases such as Jose Antonio Gonzalez *(Figure 4)*, a public cleaner in Madrid who suffered a fatal heat stroke while working in 40-degree temperatures, or Fernando Uceta *(Figure 3)*, a man with chronic obstructive pulmonary disease who, due to his medical condition and financial situation, is confined to his home during extreme heat but lacks the means to properly cool his living space. These personal stories highlight the intersection of social vulnerability and urban heat, illustrating how existing inequalities are exacerbated by rising temperatures.

This chapter seeks to identify and address these vulnerabilities. To achieve this, a statistical analysis *(Appendix C)* was conducted to map the spatial distribution of vulnerable communities across the city. This process identified six neighborhoods where the marginalized populations regarding urban heat are mostly located. A field study conducted in November 2024 allowed for an on-site analysis of these neighborhoods, focusing on key locations such as elderly homes, hospitals, social centers, community centers, parks, and infrastructural nodes. After selecting San Cristóbal de los Ángeles as the intervention site for the design, a second field visit took place in March 2025. The observations and experiences from both visits are documented in *Appendix A*.

How is vulnerability to urban heat defined and experienced, and in what ways do underlying social and structural inequalities determine how the most vulnerable are disproportionately affected?

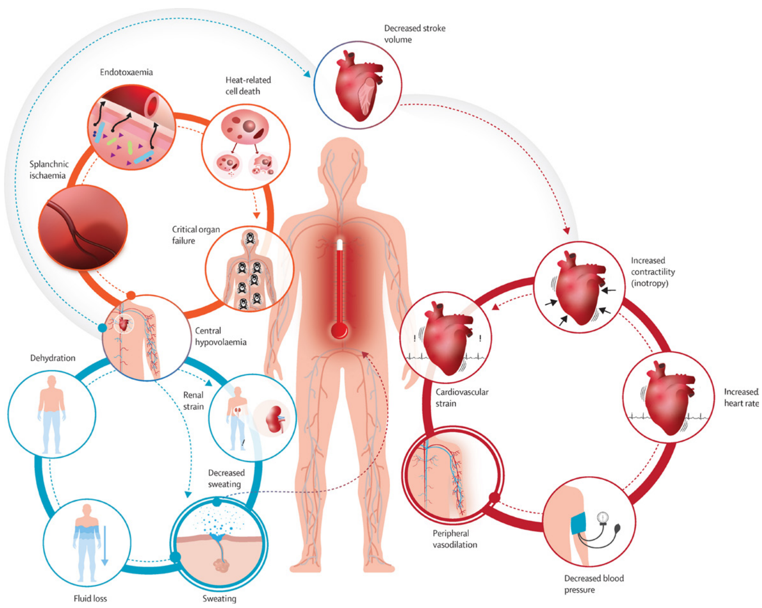
[FIGURE 3]
Fernando Uceta

[FIGURE 4]
Jose Antonio Gonzalez's son holding a picture of him.

CONDITIONS

The city of Madrid is located in a semi-arid and Mediterranean climate as classified by the Köppen-Geiger system. Situated at 650 meters above sea level, the city experiences a wide range of climatic conditions, with dry, hot summers and mild, cool winters. Summers typically see average temperatures exceeding 25°C, with peaks between 32°C and 33.5°C, and often surpassing 40°C during extreme heatwaves *(Oquendo-Di Cosola et al., 2021)*. Winters have cooler conditions, with temperatures occasionally dropping below 0°C. The annual temperature range is high, fluctuating by as much as 19 to 20 degrees. The summer and winter period are also marked by their dryness, with rainfall concentrated in the spring and autumn seasons *(Sobrino et al., 2013)*.
While the Köppen-Geiger classification offers a general framework, it does not account for the localized climatic variations that can be found in a city. Urban morphology, materials, and anthropogenic activity influence microclimates, with the Urban Heat Island (UHI) effect emerging as one of the most significant condition in Madrid.

During the summer periods, the UHI effect can elevate urban temperatures by up to 8,5°C compared to its surrounding rural areas *(Arup, 2023)*.
Urban heat poses health risks, particularly during prolonged periods of elevated daytime and nighttime temperatures, which can place strain on the human body *(Sánchez-Guevara et al., 2017)*. A consequence of excessive heat exposure is thermoregulatory stress, or heat stress, which disrupts the body's ability to regulate its internal temperature. This can lead to a variety of health issues, ranging from mild heat cramps to severe, potentially fatal heatstroke *(Huia et al., 2019)*. Another concern is dehydration, which increases morbidity and mortality rates, especially among vulnerable populations such as the elderly. Older adults often experience a diminished sense of thirst, making them more susceptible to dehydration during heatwaves. This vulnerability is further exacerbated by pre-existing health conditions and the use of certain medications that impair thermoregulation *(Ramly et al., 2023)*.



[FIGURE 5] Illustration of the physiological pathways of human heat strain (Ebi, et al., 2021)

CLIMATE JUSTICE

Climate justice is a critical framework for addressing the disproportionate impacts of climate change. It seeks to ensure that the benefits and burdens of climate measures, including those aimed at mitigating urban heat, are distributed among all populations. This approach encompasses three dimensions: distributive justice, procedural justice, and recognitional justice *(Mohtat & Khirfan, 2021)*.

In the context of urban heat vulnerability, distributive justice focuses on the fair allocation of resources and opportunities to reduce urban heat exposure. Marginalized populations, often residing in densely built neighborhoods with limited green spaces and inadequate access to cooling facilities, are disproportionately exposed to extreme temperatures due to the UHI effect. Socio-economic factors such as poverty, low educational attainment, and pre-existing health conditions further exacerbate their vulnerability, limiting their ability to adapt, for instance, by installing air conditioning or relocating to cooler areas.

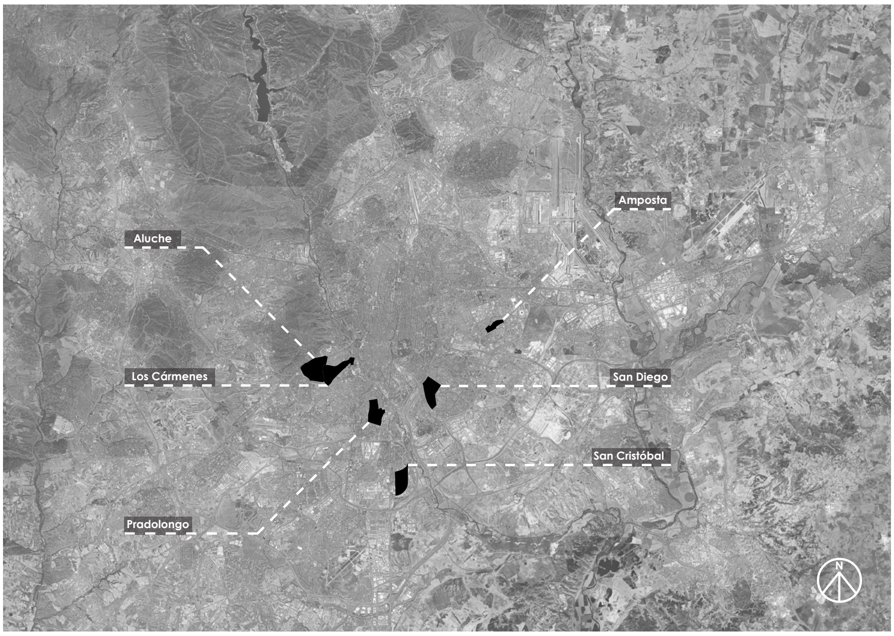
Procedural justice emphasizes the importance of inclusive and participatory planning processes in the development and implementation of climate adaptation strategies. Top-down planning approaches risk reinforcing existing inequalities and producing unfair outcomes, whereas participatory processes can lead to more equitable and effective adaptation measures. Marginalized populations must have a voice in decision-making to ensure that their needs and perspectives are reflected in policies aimed at reducing urban heat.

Recognitional justice calls for the acknowledgment of historical patterns of inequality, oppression, and segregation that have contributed to current vulnerabilities to heat. It highlights the importance of recognizing the diverse needs, experiences, and cultural identities of different populations, particularly those most affected by extreme heat. Without this acknowledgment, adaptation strategies may overlook critical social dynamics and fail to address the root causes of vulnerability *(Mohtat & Khirfan, 2021)*. Additionally, while interventions can provide significant cooling benefits, they can also lead to unintended consequences, such as climate gentrification. This occurs when climate adaptation investments increase property values and rents, potentially displacing economically disadvantaged residents. To avoid exacerbating social inequalities, it is essential to anticipate and mitigate these risks during the planning and implementation of adaptive measures.

An integrated approach to climate justice in urban heat mitigation combines distributive, procedural, and recognitional justice. Some examples include improving housing conditions in low-income neighborhoods, implementing targeted awareness programs on heat risks and coping strategies, and ensuring equitable access to adaptive infrastructure *(Amorim-Maia et al., 2023)*. By embedding climate justice into urban heat adaptation strategies, cities like Madrid can develop more inclusive, resilient, and equitable responses that prioritize the protection of their most vulnerable populations.

SHANTY TOWNS

During my field trip to Madrid in November 2024, I visited six neighborhoods identified as having relatively marginalized populations *(Figure 6)*. I explored the infrastructures surrounding these neighborhoods, including modes of transportation, the Manzanares River, parks, sewage systems, emergency services, and telecom systems. My initial aim was to identify potential vulnerability spots within these neighborhoods and their associated infrastructures. However, I encountered a population that had previously escaped my attention, a group potentially among the most vulnerable to extreme climate conditions: the homeless population. These individuals often live in “chabolas,” informal settlements constructed from various found materials *(Figure 7)*. These shelters are typically located in areas offering some protection from the elements and grow over time until they are dismantled by the municipality. This continuous displacement leaves the homeless population without security in their whereabouts or security of shelter capable of protecting them from (extreme) climate conditions.



[FIGURE 6]
The six neighborhoods identified as having relatively marginalized populations

Additionally, these shelters and the surrounding areas often face significant safety and health challenges. Many individuals within this population struggle with drug addiction, which can lead to involvement in criminal activities such as theft or even solicitation. These behaviors, together with the clustering of homeless populations around infrastructural nodes, can make these spaces unsafe, effectively causing these nodes to "fail" as functional urban components. The areas around these shelters contain garbage, including syringes and other unsanitary materials, further adding to the health and safety issues *(Figure 7)*. Besides the access to basic needs such as water, food, heat and cooling is often a challenge for this population.

[FIGURE 7]
A chabola, an informal settlement that falls outside official rules and regulations also know as "Chabolismo", "Infraviviendas", "Suburbios", Cuevas" or "Chozas".

The homeless population in Madrid is primarily concentrated in the southern parts of the city, constantly moving as their shelters are dismantled *(Figure 8)*. Their makeshift homes are constructed from scavenged materials such as scrap wood, tarps, abandoned furniture, and other items they can find *(Figure 7)*. In some cases, these populations shift from infrastructure nodes into neighborhoods, possibly occupying "narcopisos", or squatted apartments converted into drug dens. These spaces become hubs for drug use and sales, creating unsafe environments within and around the affected neighborhoods. This phenomenon in Madrid not only highlights the vulnerability of the homeless population to extreme climate conditions but also underscores the broader social and infrastructural challenges.

The emergence of shanty towns in Spain was closely linked to rural-to-urban migration, as individuals seeking economic opportunities in cities were unable to access formal housing. This phenomenon became particularly pronounced during the 1950s and 1960s, when housing shortages escalated into a major political issue under the Franco regime. The Franco regime, led by General Francisco Franco, was an authoritarian dictatorship that ruled Spain from 1939 to 1975. During this period, social policies such as affordable housing were often neglected. This led to the existence of chabolas, makeshift dwellings constructed without proper building permits or infrastructure. These informal settlements not only reflected economic inequality and urban planning deficiencies, but also placed their inhabitants in a precarious legal position, as they lacked formal recognition and were at constant risk of eviction or displacement. The unregulated expansion of these settlements was perceived as a crisis, as it strained municipal resources and intensified social and political tensions. The marginalization of chabolas' residents, compounded by their legal insecurity, reinforced their exclusion from formal housing policies and social services, until the "Poblados Dirigidos" plan was formed.

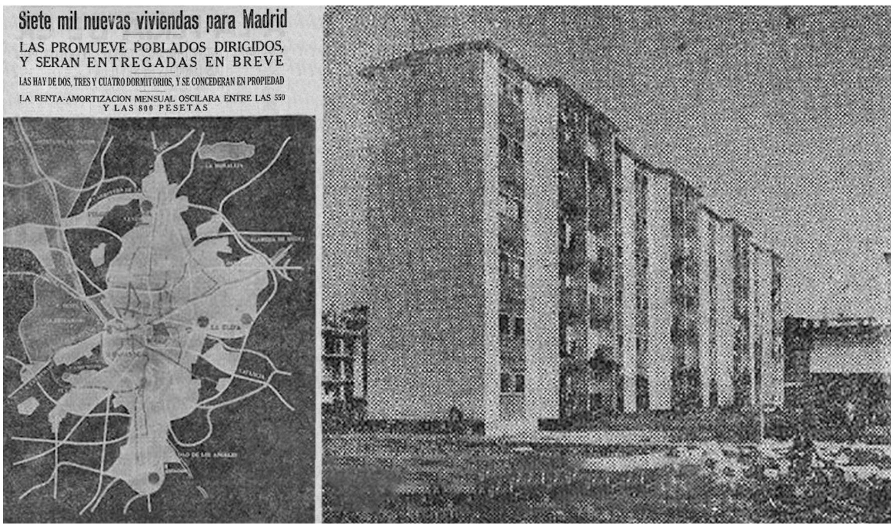
[FIGURE 8]
A homeless man pushing a shopping cart filled with his belongings through the streets, constantly being displaced as he navigates an urban landscape that offers him no stable refuge.

POBLADOS DIRIGIDOS

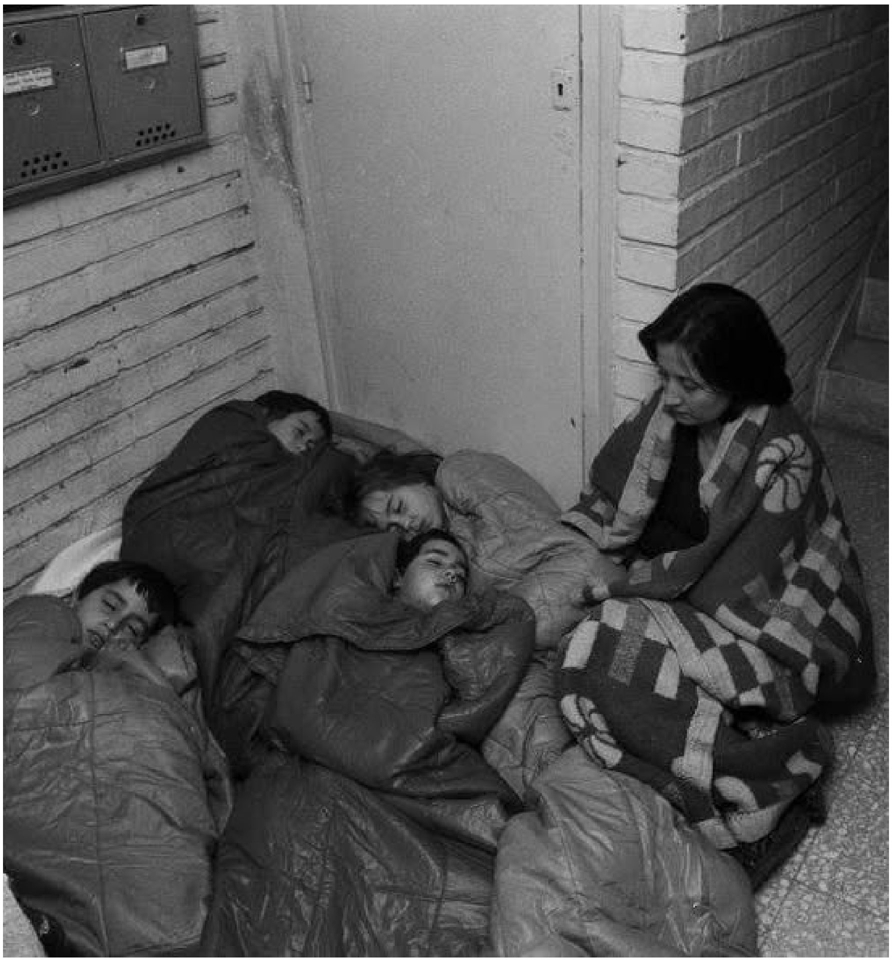
The 1954 National Housing Plan was a pivotal moment, initiating efforts to construct affordable housing while simultaneously targeting the elimination of shantytowns. This plan emphasized the construction of price-controlled housing to accommodate low-income families but often failed to meet the growing demand. As a result, many migrants continued to reside in informal settlements.

The housing issue was eventually classified as a social emergency in the late 1950s. This plan included the demolition of shanty towns and the displacement of its residents. It aimed to construct 60,000 housing units within two years, though only a part was allocated for rehousing the displaced inhabitants of the shanty towns. The plan also empowered authorities to enforce migration controls, prohibiting new arrivals without pre-arranged housing and enabling the Civil Guard to demolish illegal structures and deport residents back to their villages.

The construction of “Poblado Dirigidos”, or absorption villages, was introduced to cope with the housing crisis. These neighborhoods, often poorly built, earning the nickname “Chabolismo vertical”, or vertical shacks due to their substandard conditions. While the Franco regime sought to modernize the city and eliminate informal settlements, its policies often prioritized urban aesthetics and social control over social welfare. These interventions have shaped the lives of the displaced people and highlights the challenges of balancing rapid urbanization with social equity. The Franco regime’s approach of demolishing shantytowns while constructing low-cost social housing, sought to control the urban growth and enforce social order *(Vorms, 2013)*.



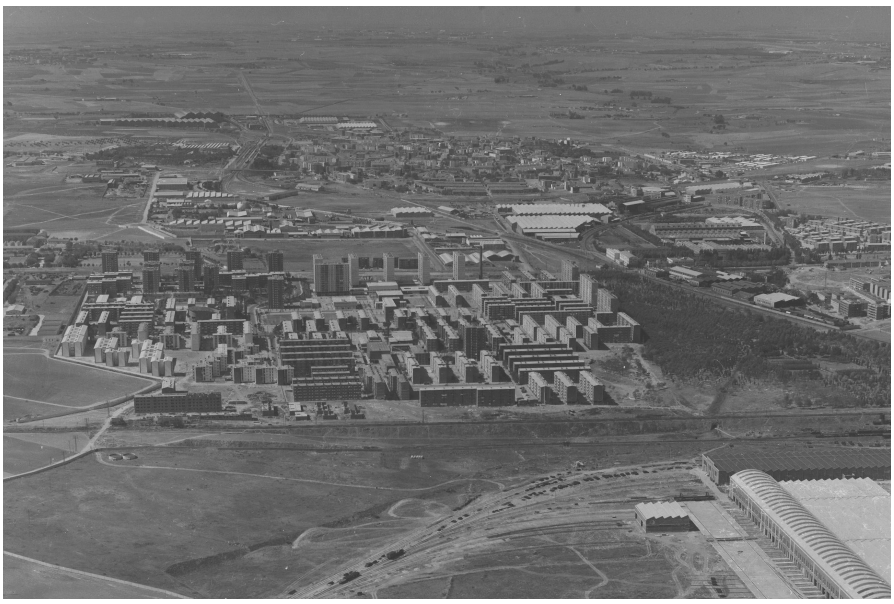
[FIGURE 9]
Seven thousand new homes by the Poblados Dirigidos project. On the right, one of the blocks of the neighborhood of San Cristóbal de Los Angeles. Hoja del Lunes, March 1960



[FIGURE 10]
A married couple and their four children sleep in the doorway of a block of flats in San Cristóbal de los Ángeles in October 1978 due to lack of a place to live.

[FIGURE 11]
A homeless man sleeping in front of a block of flats in San Cristóbal de los Ángeles in November 2024 due to lack of a place to live.

The legacy of Madrid's 1950s shantytowns is still present today, both physically in the informal settlements and socially in the continued marginalization of displaced populations. In the present day, migration mainly originates from overseas regions like South America and North Africa, in contrast with the rural-to-urban migration from the 1950s. In San Cristóbal de los Ángeles, nearly 50% of residents are foreign-born. As Spain faces new waves of immigration, urban planning this time must balance economic growth with social inclusion. Recent measures, such as granting 300,000 undocumented immigrants Spanish citizenship annually to boost the workforce *(Artusa, 2024)*, will influence the influx of immigrants in the periphery once again. Yet, the historical lessons of Madrid's shantytown crisis have not been solved with the Poblados Dirigidos project. This project shaped and continues to shape the lives of displaced populations. It raises the question of how we design affordable housing that not only accommodates growth, but also protects and supports the most vulnerable in the city.



[FIGURE 12]
The Poblados Dirigidos project completed in San Cristobal de Los Angeles, September 15th 1966.

02.
SEEKING SHELTER

Seeking shelter is not only about finding protection from urban heat, it is intertwined with psychological, social, and structural vulnerabilities. Shelter solutions must go beyond addressing physical needs alone. For many vulnerable populations, challenges such as homelessness, inadequate housing, and restricted access to cooling infrastructure are not isolated issues but rather implications of deeper patterns of exclusion. These exclusions may stem from social isolation, physical or mental health conditions, or limited access to education and essential resources. These underlying factors not only heighten individuals exposure to urban heat but also influence their ability to seek shelter.

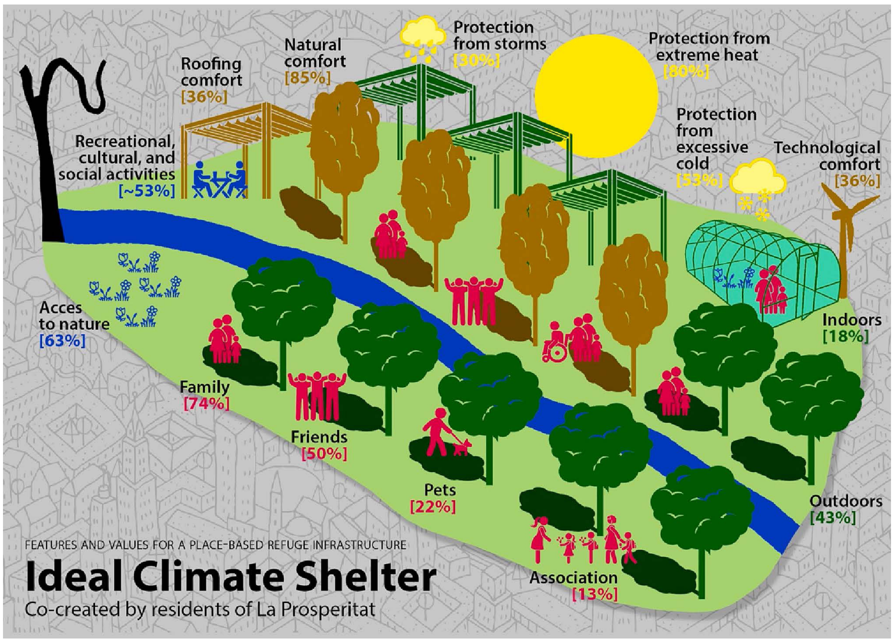
Urban heat mitigation strategies, therefore, must include interventions that address these social and psychological dimensions. The provision of shelter should not merely offer temporary relief in the face of an extreme heat event, but also create opportunities for reconnection, rehabilitation, and empowerment in the long-term. This means designing spaces that reduce social isolation, strengthen physical and mental well-being, and provide educational resources on heat risks and adaptive strategies.

The provision of shelter involves multiple perspectives and stakeholders, making it a complex and often contested issue. Efforts to secure safe and stable refuge for the most vulnerable populations can encounter policy conflicts, logistical challenges, and public resistance. Shelters exist within the broader urban fabric and have the potential to reintegrate marginalized populations into the community. At the same time marginalized populations have to deal with urban policies, public perceptions, and infrastructural limitations and this is brought to the shelter sometimes at the center of a community. These shelters, therefore, must balance the tensions between providing aid and managing local public concerns, as shelter initiatives can be perceived as either a necessary intervention or a strain on communities.

If the provision of shelter is considered both a necessity and a controversial space, what models exist that address the vulnerabilities of marginalized populations regarding urban heat? Addressing this question requires a rethinking of the essence of what a refuge space requires in an overheating city.

REQUIREMENTS

A comprehensive understanding of the different needs of the affected populations is needed in order to achieve an effective urban heat adaptation strategy. As previously mentioned, the provision of shelter must extend beyond physical needs to encompass social, psychological, cultural, and economic considerations. The requirements are to foster a space that is safe and peaceful and gives respite from the challenges outlined in the previous chapter *"Vulnerabilities"*, while also facilitating a connection with the broader community. A key component is community participation, which enhances the effectiveness, equity, and contextual relevance of interventions. By incorporating local knowledge and lived experiences the appropriate solutions for the local context can be developed. The study done by Amorim-Maia *et al. (2023)* highlights how exposure to heat-related risks is shaped by socio-economic, demographic, and spatial factors. Utilizing citizen science methodologies, including surveys, focus groups, and interviews, researchers mapped the lived experiences of residents in a neighborhood, gaining insights into thermal comfort, accessibility challenges, and social dynamics. This ensures adaptation measures are grounded in empirical, community-based evidence. By engaging residents, a deeper understanding is gained of the community's preferences *(Figure 14)*. In the case of the neighborhood in Barcelona the certain preferences were expressed in percentages and made visible in a diagram *(Figure 13)*.



[FIGURE 13]
Diagram of the "Ideal Climate Shelter" according to the residents of neighborhood La Prosperitat in Barcelona, Spain. (Amorim-Maria et al, 2023)

Beyond these statistics the value also lays in the stories of the community, getting a more in depth perspective of the specific vulnerabilities of different groups and their lived experiences regarding urban heat in residential but also public spaces, including barriers to accessing cooling infrastructure.

Hassan Fathy *(1969)* emphasizes the importance of engaging communities in a participatory design process, ensuring that solutions reflect the local social structures, cultural practices, and materials. By involving the populations in the creation and maintenance of shared public spaces, they can develop a sense of ownership and purpose, reinforcing the integration in the community. Gardens have long served as vital spaces of shelter, resilience, and well-being within the urban landscape, offering both physical and psychological refuge against environmental and social stressors. The physical aspects of vegetation are explored in Chapter 3, *“Shifting the Balance”*, where it is presented as one of seven key themes. Beyond its physical properties, vegetation also contributes psychologically. During periods of heat stress, Lafortezza *et al. (2009)* found that vegetation enhanced individuals’ perceived sense of well-being.

However, beyond their climatic function, gardens have historically been cultural sanctuaries. As explored by Harrison *(2008)*, gardens have long served as havens of tranquility, counteracting the destabilizing forces of history and change. Cultivating gardens is associated with mental well-being, as it naturally lend themselves to fostering social interaction and communal activities, with conversation, dialogue, friendship and storytelling taking place in these spaces. Even in marginalized urban settings, such as improvised gardens created by homeless individuals, these spaces introduce order, structure, and a sense of stability. The innate human desire to connect with nature, referred to as biophilia, reinforces the psychological and emotional benefits of gardens. From an urban design perspective, gardens help humanize the built environment, counteracting the vast, impersonal nature of the social housing projects that can be found on the periphery of Madrid. They also function as spaces of reflection and restoration, where slowing down and engaging with the surroundings cultivates memory, contemplation, and a sense of belonging and ownership.

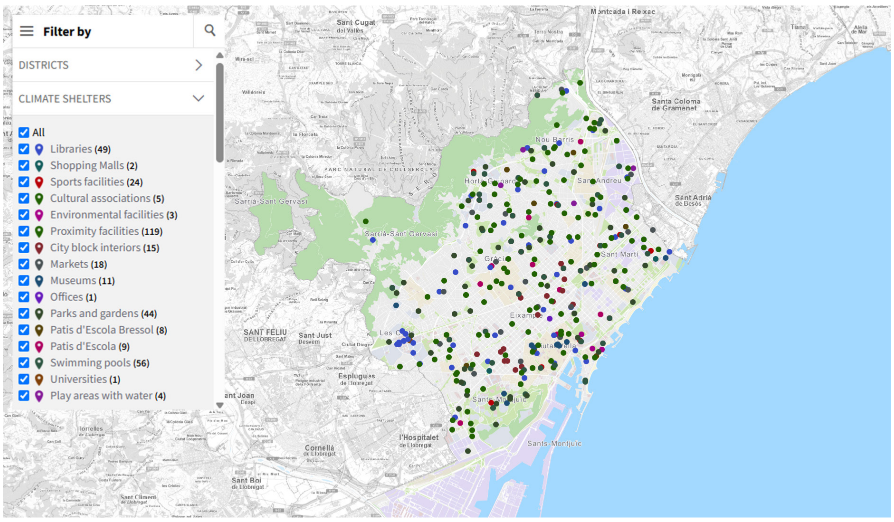
In this way, gardens are not only used as climate-responsive infrastructure, but as spaces that integrate social, cultural, and psychological needs. By designing with and for the community, adaptation strategies become not only more effective, but also more aligned with the experiences of those they are meant to serve.

[FIGURE 14]
Homeless immigrant from Cameroon set up a shelter just outside of the neighborhood San Cristóbal de los Ángeles. Enjoying the pleasures of music inside his informal settlement

CLIMATE SHELTER NETWORK

Climate shelters are spaces designed to mitigate thermal stress, offering both immediate relief and long-term adaptation strategies. However, beyond their physical function, climate shelters provide spaces for human well-being, inclusivity, and resilience. Several cities, such as Paris, Rotterdam and Barcelona, have established climate shelter networks, integrating cooling strategies within the urban fabric to address heat vulnerabilities. While these cities differ in geography, climate, and governance, they share a common approach: designing spatially distributed, accessible, and multifunctional climate shelters. Barcelona has established one of the most comprehensive Climate Shelter Networks globally, consisting of more than 350 shelters. These spaces are designed to provide relief from both summer heat and winter cold, ensuring that residents have access to safe and thermally comfortable environments year-round. The shelters are diverse in function, including libraries, shopping malls, sports facilities, cultural centers, environmental hubs, markets, museums, offices, and universities.

A key feature of Barcelona's system is its publicly accessible online platform, where each shelter has a dedicated page displaying opening hours and specific properties. These properties range from physical ones, such as the availability of drinking water, public fountains, and accessibility for individuals with disabilities, to more psychosocial ones, such as internet access and pet-friendly policies.



[FIGURE 15] Barcelona's Climate Shelter Network interface on their website

It is a space where you can protect yourself from heat or cold while maintaining its usual use.

There are indoor spaces, such as libraries or civic centers, and outdoor spaces, such as parks or the interior of blocks.

All are free except for municipal swimming pools, which have fixed public prices and assistance.

They have good accessibility and, preferably, should have chairs or benches to sit on and free water.

26º

In indoor spaces, it is recommended to maintain a set temperature in the air conditioning system of 26 °C during the hot period and 21 °C during the cold period.

They are NOT intended for people who require medical attention, who should go to the relevant health center.

Some of them offer activities or readings to make your stay more pleasant.

[FIGURE 16]
The properties of a Climate Shelter Network facility in Barcelona

REFUGIS CLIMÀTICS

Utilitza aquest espai per protegir-te de la calor

Districte d'Horta-Guinardó

Ajuntament de Barcelona

[FIGURE 17]
The mark of a Climate Shelter Network facility in Barcelona

The effectiveness of climate shelters depends not only on their individual existence but also on their spatial distribution, accessibility, and integration into a network throughout the city.

Firstly a well-designed network ensures widespread accessibility. Strategically distributing climate shelters across a city ensures that all residents can reach a climate shelter. Factoring in walkability and public transport access is critical in making these shelters accessible to all populations.

Secondly, it should address the vulnerabilities of urban heat at multiple scales. Urban heat occurs at different scales, from local neighborhoods to major transit corridors. A networked approach ensures that cooling interventions operate across different levels, mitigating heat stress in both residential areas and high-traffic public spaces. Additionally, the network provides a variation of functions. Not all climate shelters function in the same way. By integrating indoor, outdoor, and hybrid cooling solutions, a network maximizes the availability of varied cooling options, allowing residents to choose the most appropriate shelter for their needs.

Lastly, it enhances the resilience of the community. Climate shelters can serve as more than just cooling stations, they can function as community hubs. By fostering social cohesion and knowledge-sharing in these shelters, communities can develop adaptive capacities, ensuring that individuals are not just passively seeking relief but actively learning to cope with extreme heat.

However, a climate shelter network is only part of the solution, ensuring that people are aware of and can access these facilities is as important. Digital tools enhance the effectiveness of shelter networks by identifying vulnerable areas and dynamically allocating resources based on changing conditions *(Figure 15)*. Public platforms that provide real-time information and direct people to the nearest climate shelter can improve responsiveness during heatwaves. Certain vulnerable populations, such as elderly people or homeless people may not have access to digital tools. That is why there is also a need for alternative outreach strategies, such as physical signage, local engagement initiatives, and targeted awareness campaigns. Additionally, heatwave emergency response plans activate early warning systems, coordinate healthcare and social services. Often developed in collaboration with communities, they enhance the local capacity and outreach. In some cities increasingly affected by extreme heat, a Chief Heat Officer (CHO) is appointed, to lead and coordinate comprehensive heat mitigation strategies *(Shaw & Colclasure, 2022)*. CHOs are tasked with coordinating heat mitigation strategies, assessing risk, mobilizing public engagement, and integrating heat adaptation into broader urban planning. They serve as the bridge between the research, policy, and community needs.

03.

SHIFTING THE BALANCE

The goal in addressing the urban heat problematic in Madrid, can be simplified to two approaches which eventually have to be combined into one intervention. There is the sociological approach which was addressed in the previous chapter *“Seeking Shelter”* and then there is the technical approach which will be addressed in this chapter. The physical aspects regarding urban heat consist of reducing the Urban Heat Island (UHI) effect and improving the Outdoor Thermal Comfort (OTC). The research in this area is quite extensive with research being done in other cities, facing similar challenges. The body of research which will be used for this research comes from the project *“Cooling Singapore”*, which was published in 2017 *(Ruefenacht & Acero, 2017)*. It consists of a catalogue with 86 strategies, subdivided into 7 clusters: vegetation, urban geometry, water features and bodies, materials and surfaces, shading, transport, and energy.

This chapter looks at the occurrence of urban heat in the city of Madrid as a potential benefit instead of a threat. By shifting this paradigm we can look at the potential benefits, as we try to answer the question: How could urban heat be repurposed so that it would benefit the city instead of being threated as a threat?

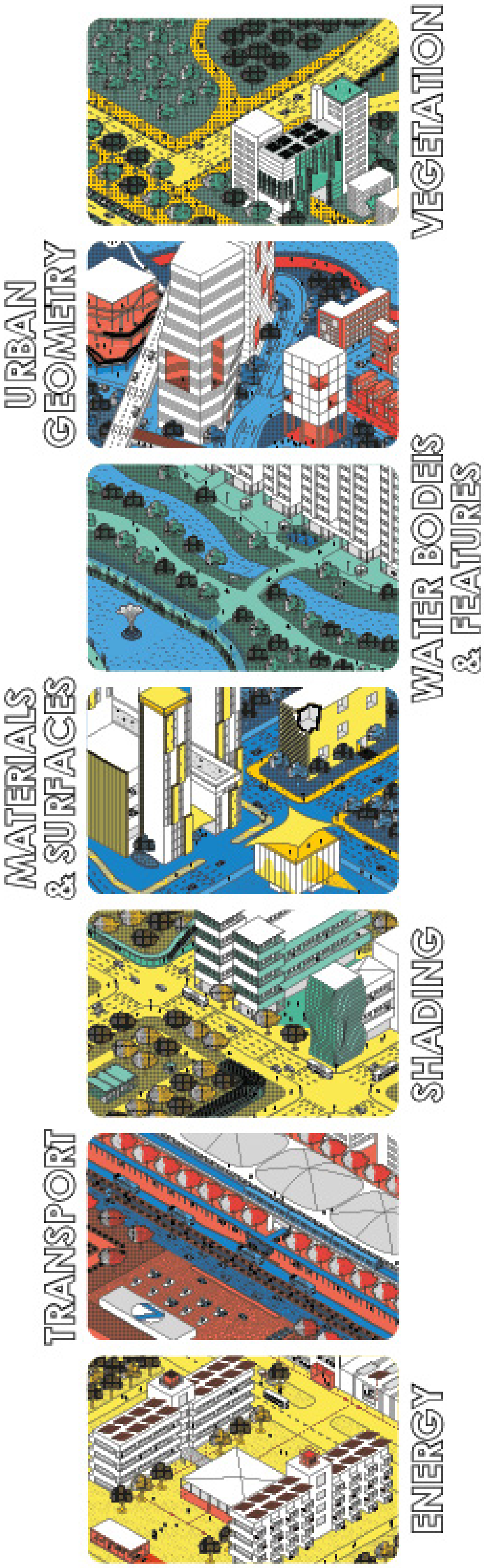
[FIGURE 18]
Typical retrofitted residential building in Madrid

MITIGATION

The mitigation of the Urban Heat Island (UHI) effect and the improvement of the Outdoor Thermal Comfort (OTC) needs a multi-layered approach that includes multiple techniques in order to achieve the most effective path towards mitigating the physical problems surrounding urban heat. Broadly we can summarize the techniques into some categories, these are reducing solar radiation exposure, wind-based cooling, water-based cooling, and material and energy efficiency.

Shading plays a fundamental role in reducing surface and ambient temperatures by minimizing direct solar radiation exposure. This strategy can be implemented through vegetation-based solutions, including green roofs, tree canopies, vertical greenery, and green corridors, all of which facilitate evapotranspiration and provide natural cooling. Architectural elements such as overhangs, shading devices, covered walkways, and facade treatments further mitigate heat gain, while urban geometry adjustments, particularly in high-density areas, can enhance self-shading effects. These interventions collectively contribute to lower surface temperatures. By decreasing heat absorption on buildings and public spaces, shading strategies also improve pedestrian comfort and lower energy demands for indoor cooling.

Secondly, ventilation and wind flow serve as a mechanism for heat dissipation, particularly in densely built urban environments where stagnant air can cause a poor OTC. Urban design strategies that facilitate airflow include the preservation of breezeways and ventilation corridors, which enable the unobstructed passage of natural wind through streets and public spaces.

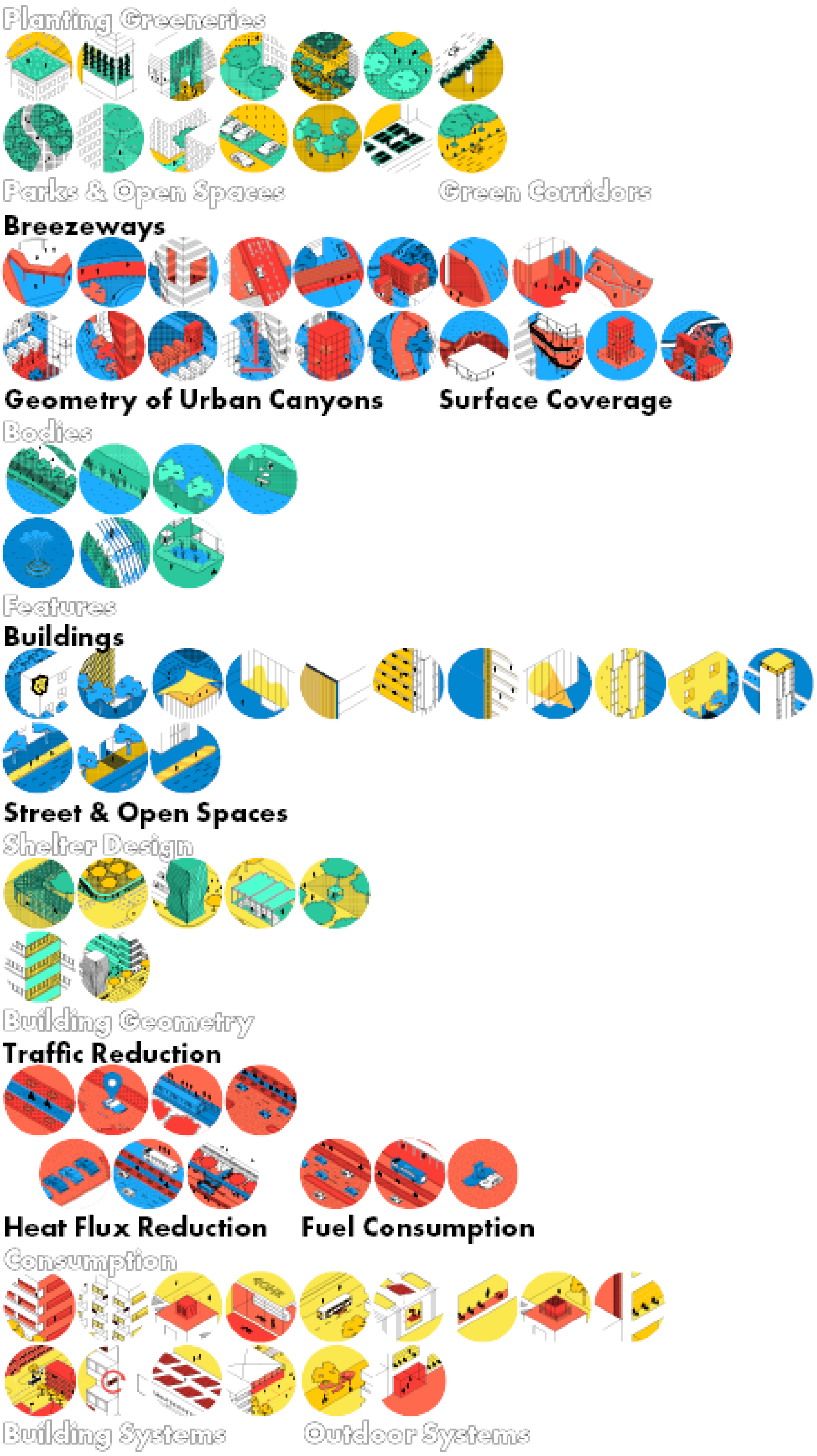


[FIGURE 19]
7 Clusters of mitigation strategies from the Cooling Singapore project

Porosity in buildings, which includes staggered layouts, void decks, and permeable urban forms, enhances air circulation at the pedestrian level. Proper street orientation, particularly in alignment with prevailing wind directions, further strengthens the cooling effect by channeling airflow through the open space. By increasing air movement, these strategies reduce perceived temperatures, enhance cooling efficiency, and lessen dependence on mechanical cooling systems. Consequently, the integration of ventilation-friendly urban planning principles not only improves the OTC but also fosters energy savings and air quality improvements.

Water-based cooling uses the thermal properties of water to moderate urban temperatures. The presence of lakes, ponds, and other water bodies helps regulate temperature fluctuations by absorbing and gradually releasing heat, creating cooling microclimates within urban landscapes. Water features such as fountains and misting systems provide localized evaporative cooling.

Lastly, material selection and energy efficiency contribute to urban heat mitigation by addressing the thermal properties of built environments. High-albedo materials, which can be placed on roofs, pavements, help reduce heat absorption and surface temperatures, thereby lowering the overall thermal load on urban infrastructure. Permeable pavements serve a dual function by not only decreasing heat storage but also allowing water infiltration, which enhances evaporative cooling potential. The adoption of energy-efficient cooling systems offers sustainable alternatives to conventional air conditioning, reducing both carbon emissions and operational energy costs.



[FIGURE 20]
The 7 clusters are subdivided into 18 subcategories, which in total contain 86 mitigation strategies from the Cooling Singapore project

(RE)USING HEAT

Throughout this paper, urban heat has been perceived primarily as a threat to be mitigated. However, complete mitigation is neither feasible nor necessarily desirable, as residual heat will persist within the urban fabric. Consequently, a paradigm shift is required, one that repositions urban heat as a potential benefit rather than a threat. By changing perspective, the focus can shift from elimination to utilization, exploring how urban excess heat can be used to serve urban energy systems. The European Union-funded *"ReUseHeat"* project *(Lygnerud et al., 2022)*, provides a comprehensive framework for identifying, capturing, and integrating waste heat from diverse urban sources. Recovering waste heat from urban sources such as data centers, water bodies, metro systems and service sector buildings contribute to decarbonization, energy efficiency, and the expansion of district heating networks with minimal investment in additional production capacity.

Data centers, for example, generate significant amounts of excess heat, which, when recovered and integrated into low-temperature district heating networks (LTDHN) using heat pumps (HP), can provide a stable heat supply for residential and commercial applications. This model illustrates how excess heat, typically at 25°C, can be upgraded to 70°C. Similarly water bodies such as wastewater from sewage canals offer a renewable source of low-temperature heat, which, through heat pumps, can be integrated into urban heating networks. Metro systems produce heat from electric motors, braking systems, and ventilation processes, which, if recovered, could serve both heating and cooling purposes. There is potential for harvesting heat from metro tunnels, particularly for direct use in adjacent buildings, thereby enhancing both thermal comfort and energy efficiency. Additionally, in Madrid, there was already a demonstration project, which explored the possibility of repurposing waste heat from hospital

[FIGURE 21]
A ventilation shaft from the metro tunnel near the neighborhood of San Cristóbal de los Ángeles. Massive amounts of heat are released from this surface

cooling towers. By utilizing booster heat pumps, temperatures were elevated for heating and hot water systems, achieving primary energy savings and CO_2 emissions reductions.

The benefits of urban excess heat reduce the reliance on fossil fuel-based heating, cities can decarbonize their energy supply and lower greenhouse gas emissions. Moreover, it enhances energy efficiency by utilizing energy that would otherwise be dissipated into the environment. From an economic perspective, waste heat integration allows district heating networks to expand without large capital investments, while also providing cost savings for industries such as data centers, which benefit from reduced cooling expenses. Furthermore, waste heat sources such as metro tunnels and wastewater systems tend to be stable and long-term, providing a reliable heating solution that increases energy security. Integrating multiple low-temperature heat sources also enhances the resilience of urban energy systems, reducing dependence on single energy sources and minimizing risks associated with supply disruptions.

CONCLUSION

The challenges posed by Madrid's Urban Heat disproportionately impact marginalized populations, particularly those who lack access to adequate shelter, cooling infrastructure, and economic resources. As climate change intensifies, rising urban temperatures not only deepen public health risks but also social inequalities. To address these vulnerabilities a multifaceted approach that integrates localized architectural interventions with urban infrastructure improvements is needed. It must combine spatial, technological, and socio-political elements to create sustainable and equitable urban environments.

The provision of climate shelters, offers immediate relief during extreme heat events. However, the effectiveness of these interventions depends on their accessibility, spatial distribution, communication and outreach and integration within existing social structures. Moreover, community-based adaptation strategies, including participatory design and maintenance, ensure that interventions are contextually relevant, equitably distributed and developed with a sense of ownership.

Infrastructure also plays a fundamental role in addressing the vulnerabilities in response to Madrid's urban heat. Marginalized communities often face limited access to cooling resources, making policy-driven initiatives, such as the establishment of a Climate Shelter Network, essential for ensuring equitable heat resilience. Such networks can leverage existing public spaces by adapting them into designated cooling zones in times of need. Importantly, these interventions must be supported by clear communication strategies that raise awareness about heat risks and available resources. Additionally, urban excess heat presents a significant opportunity for sustainable energy use. Excess urban heat not only reduces dependence on fossil fuel-based energy but also provides a stable, cost-effective heat supply for vulnerable communities.

Localized architectural interventions and urban infrastructure improvements can directly address the vulnerabilities of marginalized populations in Madrid by providing equitable access to cooling resources, enhancing thermal resilience in underserved neighborhoods, and reducing exposure to urban heat. When integrated holistically, these interventions not only mitigate the immediate risks of urban heat for vulnerable populations but also foster a more climate-resilient and socially inclusive city.

[FIGURE 22]
Site for intervention in San Cristóbal de los Ángeles (Appendix B)

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LIST OF FIGURES

A.

APPENDIX

FIELD RESEARCH

I have visited Madrid during this project on two seperate occasions. The first time with the whole ADC studio (16 students & 3 tutors) in the period of 06 . 11 . 2024 - 16 . 11 . 2024 (11 days). The second time by myself on the afternoon of 15 . 03 . 2025 (1 day).

06 . 11 . 2024 - 16 . 11 . 2024 (11 DAYS).

Where?

- *__Six__ Neighborhoods with their surroundings and infrastructures. These neighborhoods were chosen on the basis of the following parameters*:*
  - *% of people > 65 years old*
  - *% of people <16 years old*
  - *% of people with a migration background*
  - *household net rent*

What?

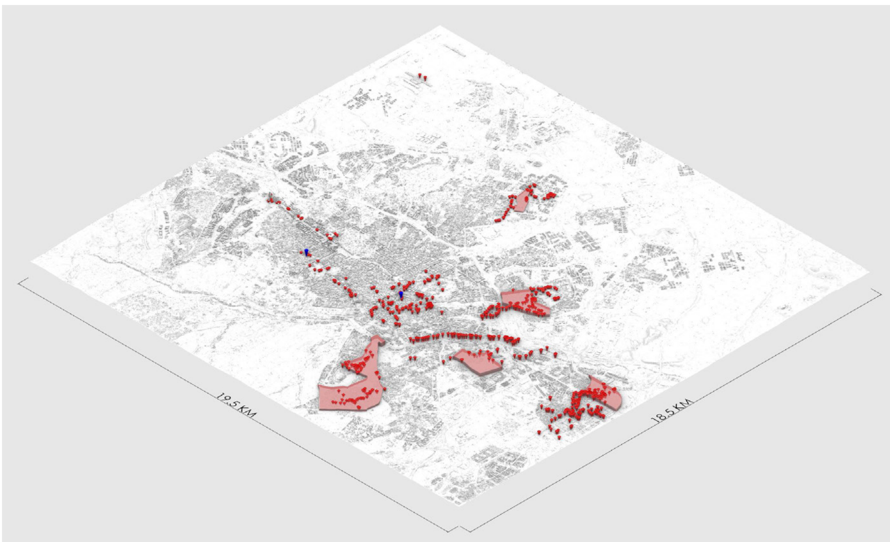
- *Urban infrastructures (e.g. Transportation networks, Water systems, Green spaces, Waste management, Energy facilities, Shaded areas, Airconditioned spaces, etc.)*
- *Behaviour in public spaces*
- *Social facilities (e.g. Community centers, Healthcare, Libraries), also in terms of potential climate shelters*
- *Urban nodes experiencing excess heat*

How?

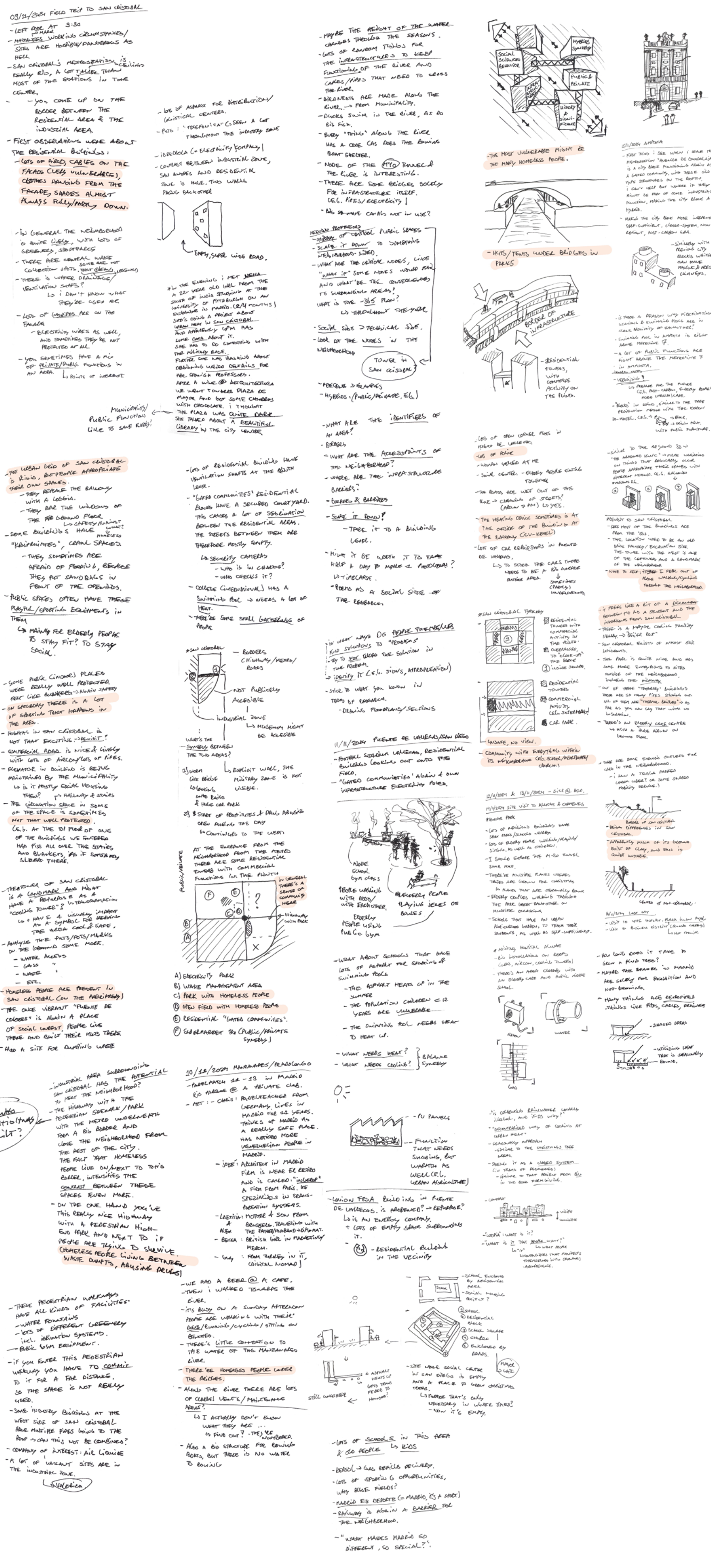
- *Seasonal context (November)*
- *Camera (Photos, videos, timelapses)*
- *Notebook*

**marginalized populations regarding urban heat.*

Summary of the activities undertaken in Madrid and the underlying motivations.

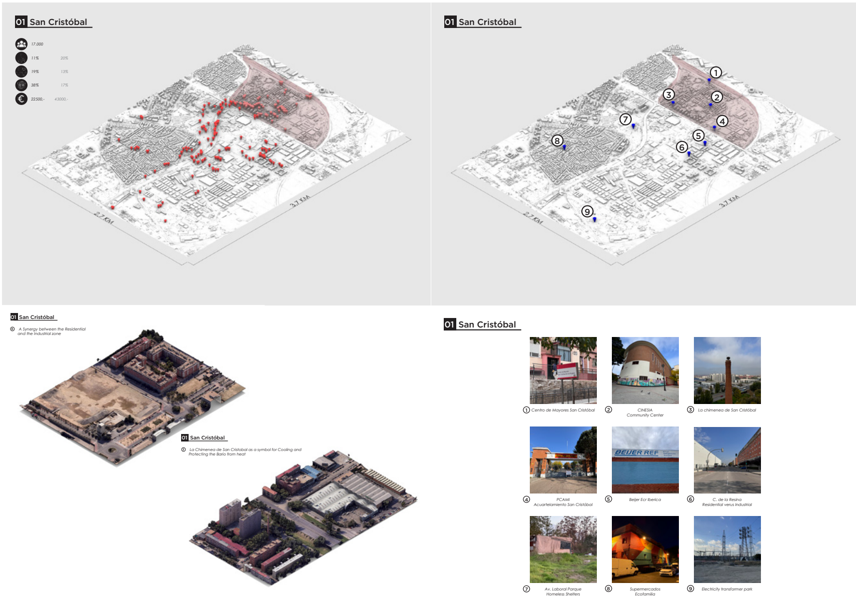


The six neighborhoods selected for analysis prior to the field visit to Madrid (San Cristóbal de Los Ángeles, Pradolongo, San Diego, Aluche, Los Cármenes, and Amposta) are indicated in light red. Red dots highlight the locations visited during the fieldwork. The two blue dots mark the places of accommodation.

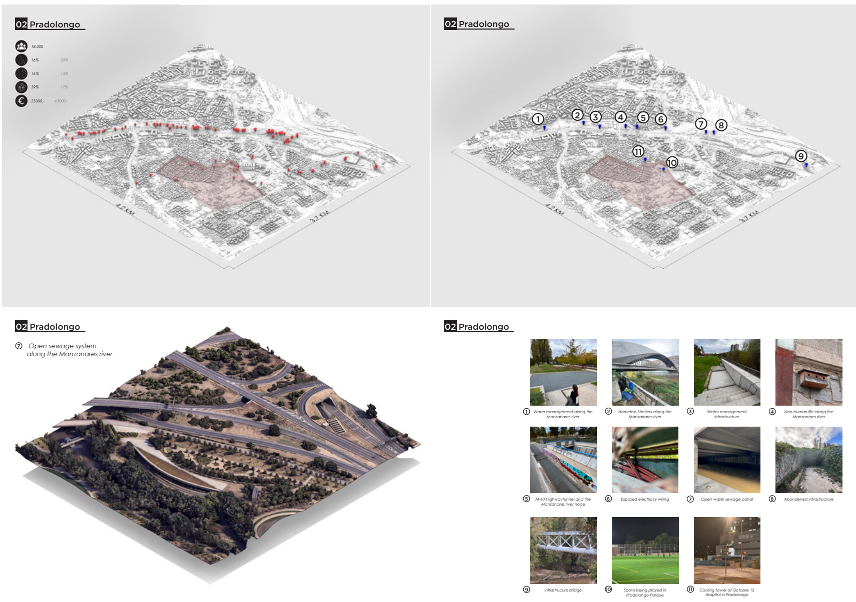


Unedited field notes recorded over the course of the 11-day visit to Madrid.

Each visit to a neighborhood is documented through an overview of the locations explored, interesting sites illustrated with photographs, and one or two potential intervention sites proposed as points of departure for further discussion.

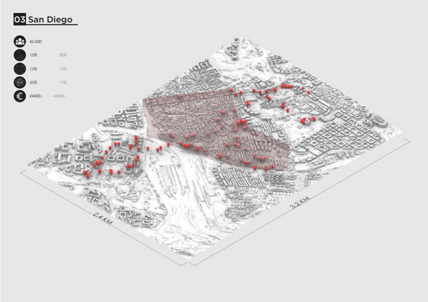


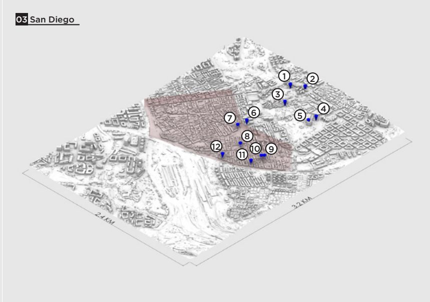
San Cristóbal de Los Ángeles and surroundings

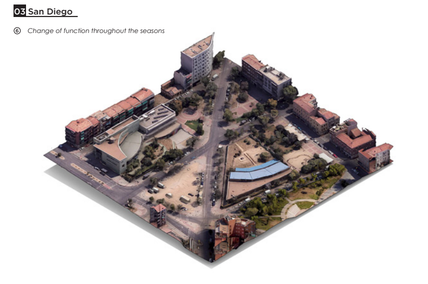


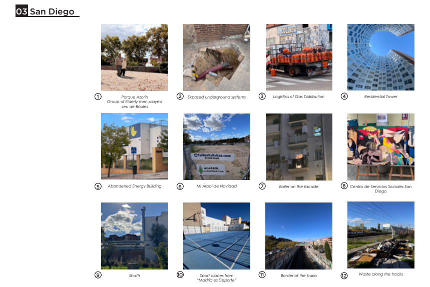
Pradolongo and the Manzanares river

San Diego and surroundings

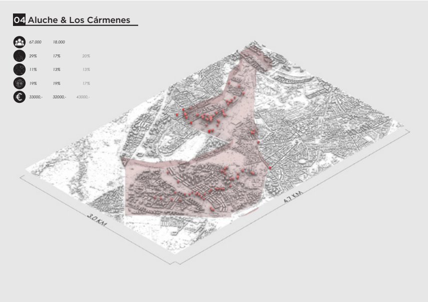


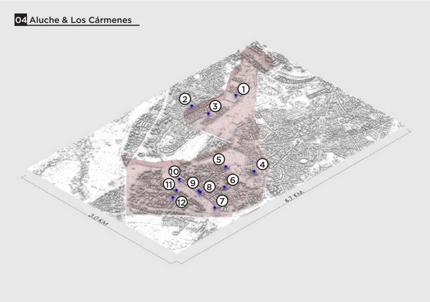




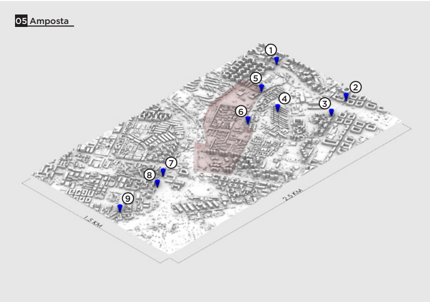


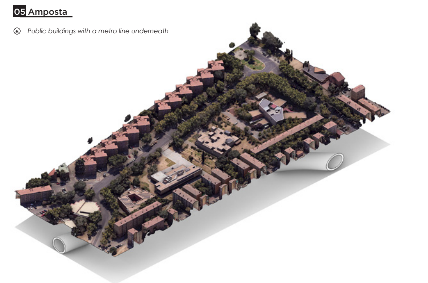
Aluche & Los Carmenes

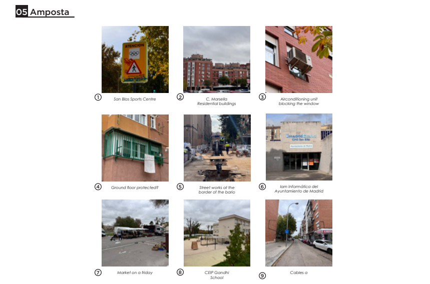




Amposta and surroundings





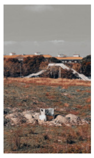


From left to right:

Club Deportivo San Cristóbal de los Ángeles, traces of homeless people along Gran Vía de Villaverde, idem, idem, idem







Traces of homeless people along Gran Vía de Villaverde, idem, idem, traces of homeless people in Aluche & Los Carmenes




Traces of homeless people along Gran Vía de Villaverde, idem, idem, street in San Cristóbal de los Ángeles




Traces of homeless people along Gran Vía de Villaverde, traces of homeless people in Madrid Rio, idem, idem

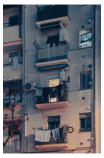
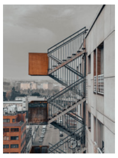



Traces of homeless people near the Manzanares river, idem, Elderly people making use of public park, idem, Asphalted tree in Lavapies

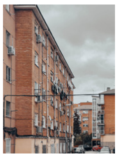




Garbage near train tracks in San Diego, Retrofitted facade in Pradolongo, Renovated building in San Cristóbal de los Ángeles, Elderly men in public park in Aluche, idem

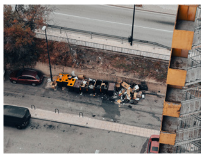




Retrofitted facade in San Cristóbal de los Ángeles, metro outlet in San Cristóbal de los Ángeles, homeless people in Madrid Rio, traces of homeless people in San Cristóbal de los Ángeles




Traces of homeless people near San Cristóbal de los Ángeles, Cooling systems supermarkt in San Cristóbal de los Ángeles, Garbage collection in San Cristóbal de los Ángeles, homeless man on bench in San Cristóbal de los Ángeles






Traces of homeless people along Gran Vía de Villaverde, traces of homeless people near San Cristóbal de los Ángeles, homeless man near San Cristóbal de los Ángeles



The City Council dismantles the San Cristóbal shanty town

The neighbors denounced the insecurity that it brought with it

Photo: EDITORIAL | Video: Telemadrid

November 13, 2024 - 8:32 PM
(Updated: November 15, 2024 - 8:11 PM)
Residents of San Cristóbal de los Àngeles (https://www.telemadrid.es/tag/San-Cristobal-de-los-Angeles/) reported on November 13 that the number of **shacks** under a bridge at the main entrance to the neighborhood had multiplied in recent months, bringing with it **fear, drug use, and drug dealing** .

"It started as a shack about four or five months ago, and from there it's grown into a large **settlement** . I estimate there are roughly thirteen of them. This is the first thing people encounter when they arrive in San Cristóbal de los Ángeles. The image is of **drug addicts** swarming around the neighborhood, but they've already settled here," Prado tells us.

They estimate that there were about **thirty people** living here in deplorable conditions. "The problem is unhealthiness, insecurity, and garbage." Residents report a real **hotbed of insecurity and filth** under this bridge and in the parks.

To go to the doctor or even to go shopping, you **have to go through this point** . "A lot of people have to go through here, and look at how it is. They can take an elderly person's chain or whatever, and they'll take it away. Anything to get a dose," Manuel says.

Félix, another local resident, always goes out with his dog for safety. "If you're carrying your cell phone or something, you run the risk of someone stealing it and running away. I go out at night and early. This area is experiencing a surge in drug addiction, with people passing stories on to each other, so I have to take him for protection."

Just two weeks ago, residents took to the streets to demand an end to this situation. For now, **police presence** has increased, and a Madrid Directo team has witnessed several arrests in different areas of the neighborhood.

Two days after this complaint, on November 15, the City Council proceeded to **dismantle** this shantytown, a hotbed of drug addiction and insecurity in the neighborhood. This is good news for its residents, who hope it will continue.

Newsarticle, Own picture

I visited a shanty town in San Cristóbal de los Ángeles on the 9th of November, which was dismantled 6 days later by the city council.

(Telemadrid, 2024)

B.

APPENDIX

RESEARCH BY DESIGN

As cities grow in both complexity and vulnerability, the role of data-driven decision-making has become more relevant than ever. The design part of this graduation project addresses these issues through a research-by-design methodology. The Research Plan: “Beyond Madrid’s Heat: A Deconstruction of Madrid’s Urban Heat Crisis” outlined the methodological approach, which incorporates GIS mapping, remote sensing analysis, and digital modeling to analyze and predict urban heat and its problematique. A central component of this research is the application of data, virtual models that simulate urban environments and assess the impact of certain variables. By integrating real-time climate, demographic, and infrastructural data, these models offer an approach to testing, optimizing, and implementing interventions before their physical implementation. The effective use of this data enables the identification of high-risk heat zones, the simulation of heat mitigation strategies, the assessment of energy efficiency in existing housing stock and potential retrofits, the enhancement of public space design for cooling, and the development of “what-if” scenarios to guide policy decisions. These tools provide a framework for urban heat adaptation strategies in the design.

The chosen site for the design is located near the center of the neighborhood “San Cristobal de Los Angeles”, a neighborhood with the lowest income per capita in the city of Madrid. Through data sources highlighted in the Research Plan this site together with the field research has been chosen. The data that is being used for the research by design method comes from different sources, the main ones being: Climate One Building, Geoportal Madrid and OpenStreetMap

Building information modeling (BIM)
Review the detailed architectural and structural data of buildings to identify heat-retaining materials and surfaces

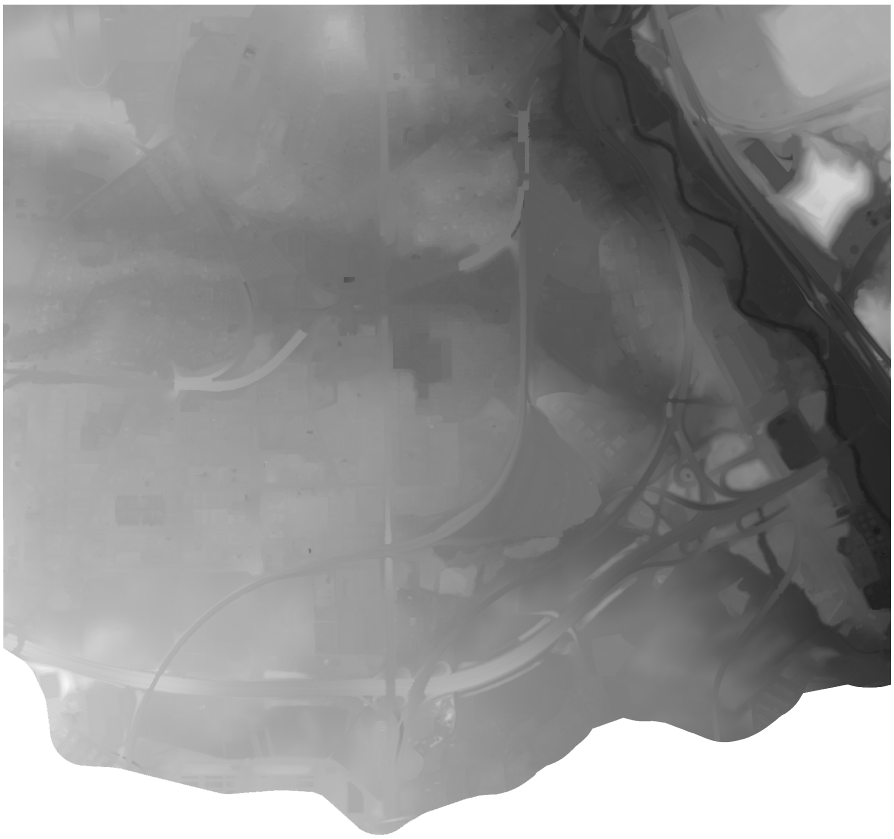
Point clouds
Analyze spatial relationships and shadow patterns to improve the placement of trees and water features

Geospatial data
Map heat-prone areas and planning interventions at a city-wide scale based on geographical information, including land use and land cover

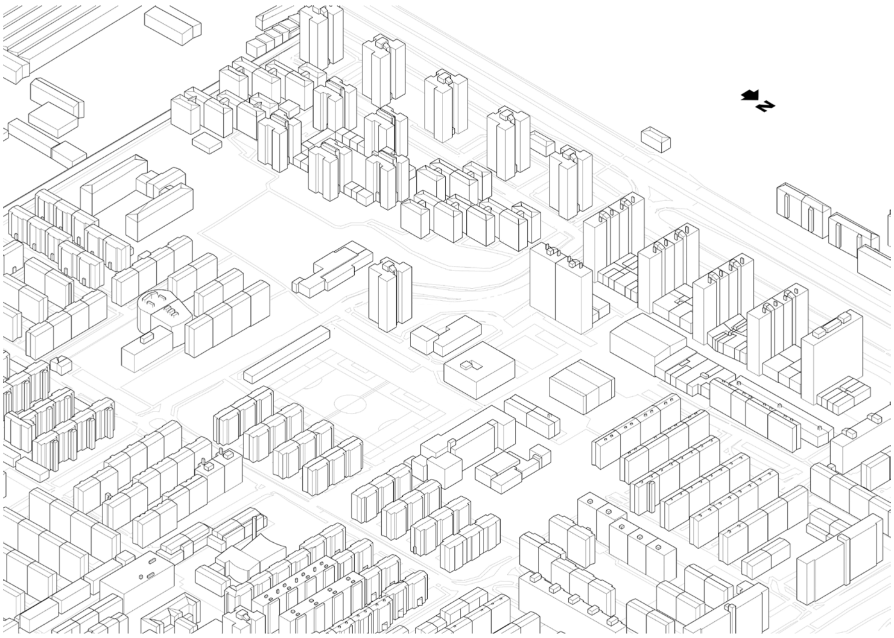
Meteorological data
Predict the effectiveness of mitigation measures by understanding local microclimates and analyzing temperature, humidity and wind patterns

Socio-economic sources
Ensure equitable heat mitigation efforts by prioritizing areas with key social and economic activities or with higher risks of heat-related health issues based on population density, income levels and vulnerable communities

Geoportal Madrid
Using site specific data from the municipality



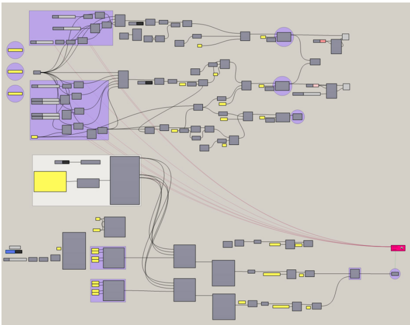
A Digital Terrain Map (DTM) of the Villaverde district, constructed using data from the Geoportal Madrid for Digital Modeling

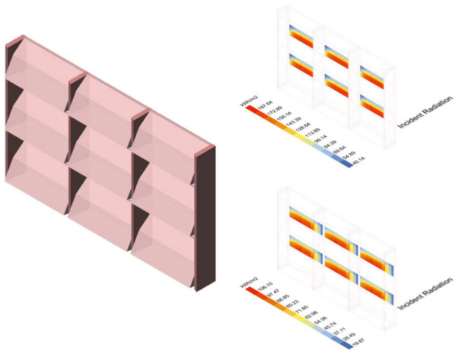


A mesh from the buildings of Madrid, categorized per district.

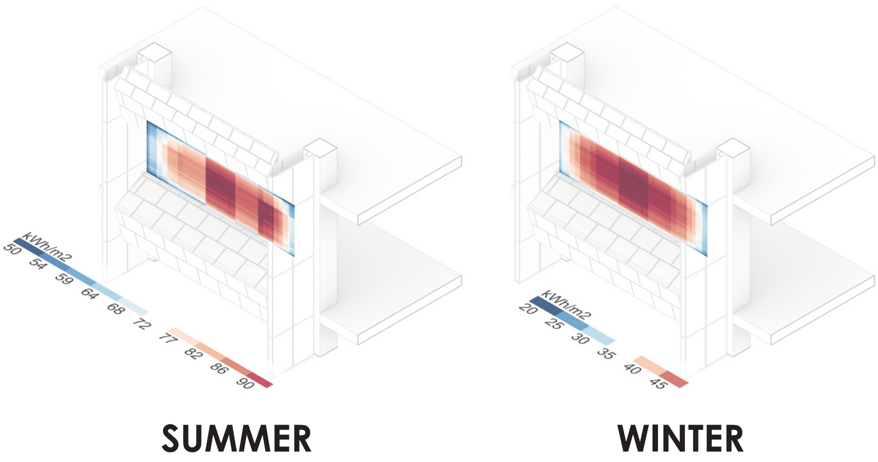
Galapagos optimization
Facade module

A script in Grasshopper, using Galapagos to optimize the geometry of the facade module. Optimized using different weights and biasses:
- maximizing solar radiation in winter.
- minimizing solar radiation in summer
- minimizing the volume of the geometry

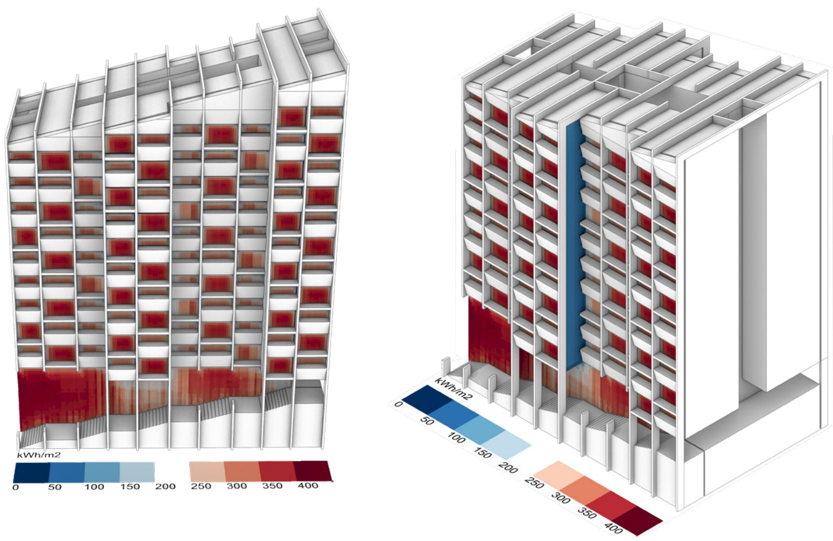




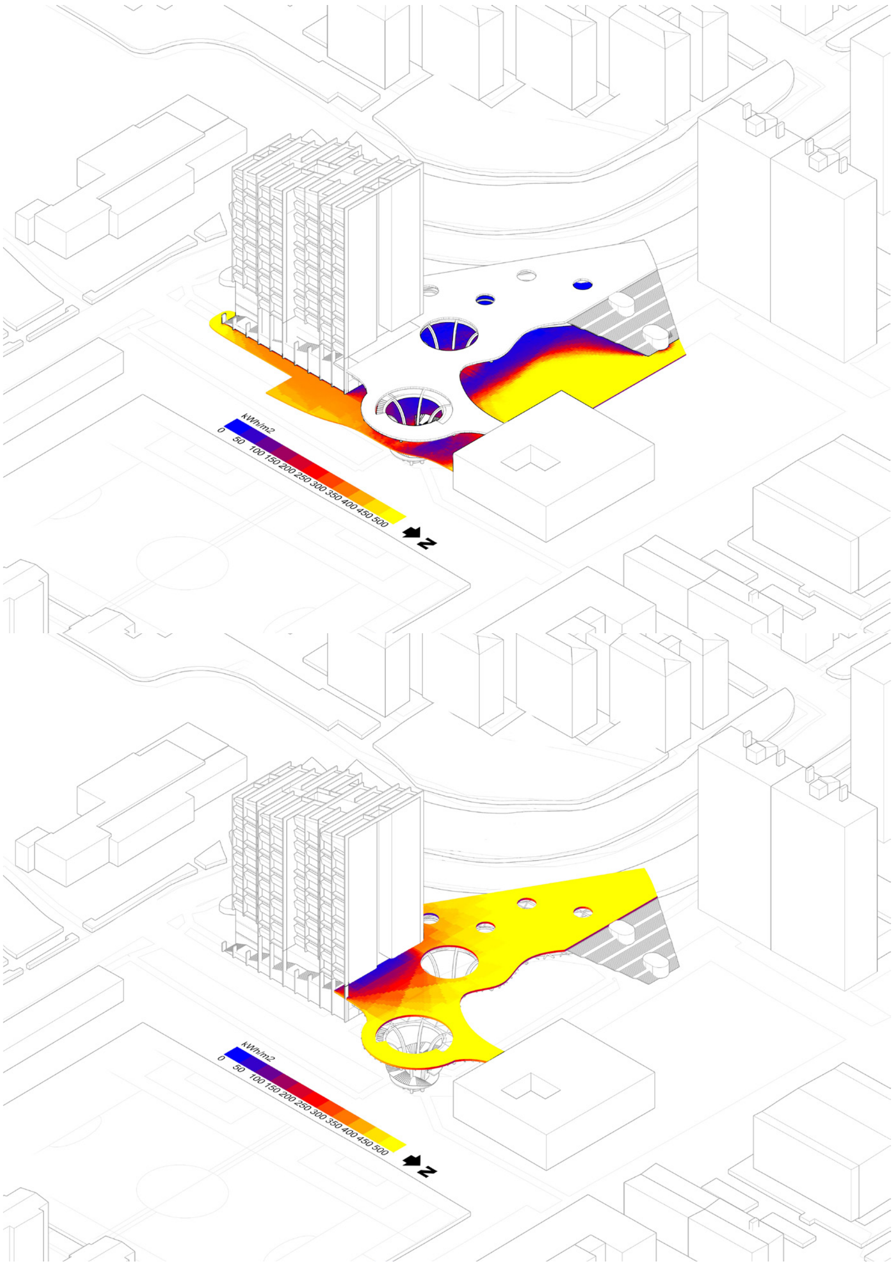
Ladybug
In order to know the temperatures of my site



A solar radiation study of the facade module

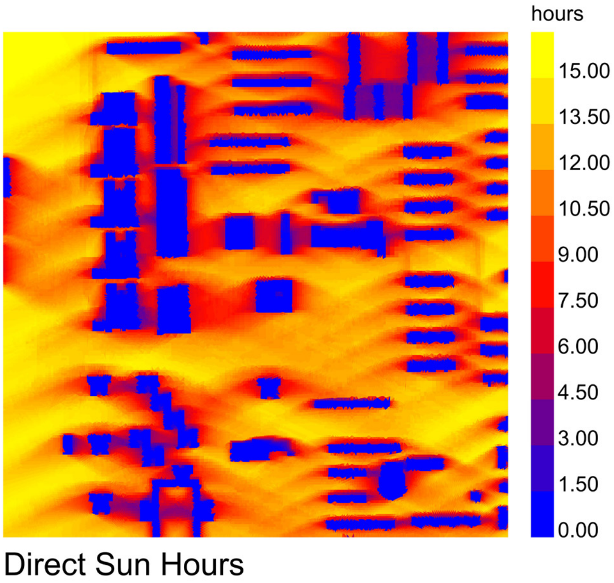


A solar radiation study of the facade as a whole

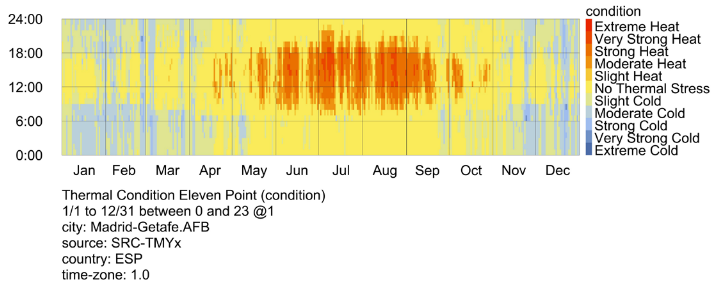


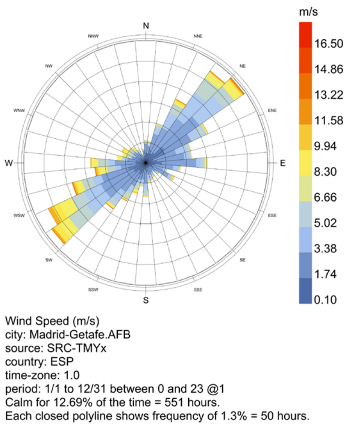
A solar radiation study of the ground plane underneath the elevated park and the elevated park

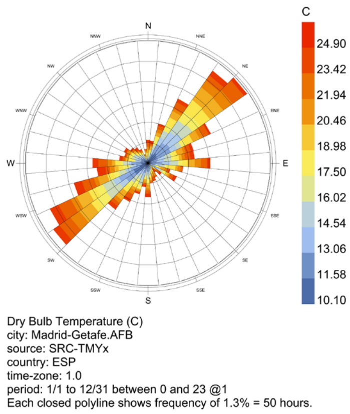
Sun hours analysis of existing situation of the site



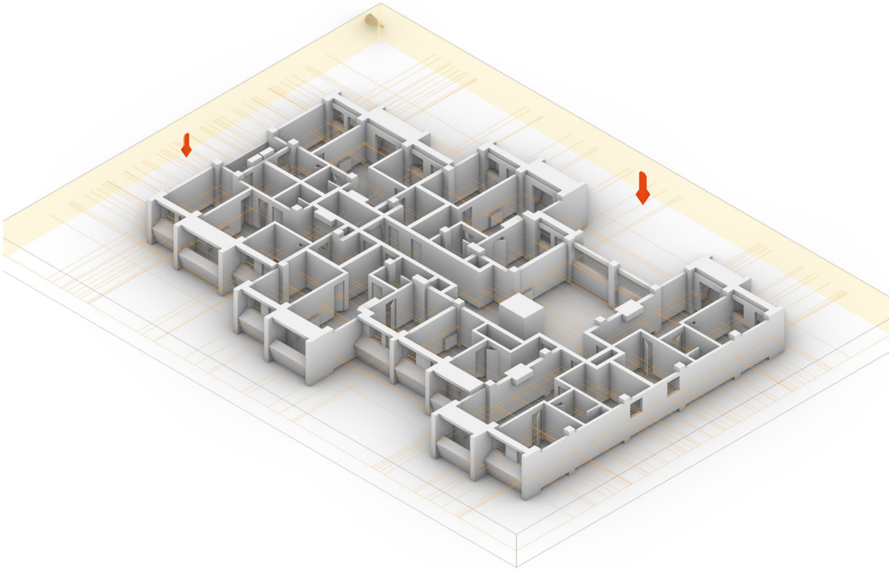
General data from the site using Ladybug to extract information collected from https://www.ladybug.tools/epwmap/

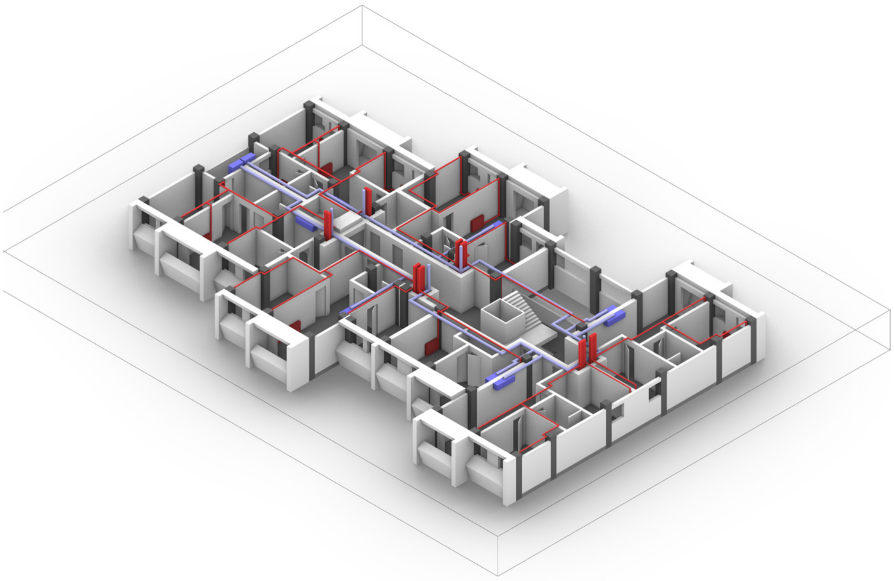






RhinoCFD (= Computational Fluid Dynamics)
To understand how the prevailing wind direction affects my site at various scales (urban, building, and interior), I carried out a wind analysis.





[The simulation from RhinoCFD did not achieve usable results yet]. Determining location of active systems in interior spaces using RhinoCFD. Using climate data to simulate an extreme cl imatic event where active systems are needed to make the interior spaces comfortable

C.

APPENDIX

STATISTICAL ANALYSIS

	Total Population	Average Age	% of People >65 years old	% of Foreign people (2023)	Household average net rent (2020)	% of People <16 years old
Column1	Column2	Column3	Column6	Column7	Column8	Column9
Abrantes	31691	42,8	17,2	24,4	30910	14,7
Adelfas	18832	45,7	22,8	8,6	50837	12,6
Aeropuerto	1902	42	14,9	23,9	28191	16
Alameda de Osuna	19685	46,3	26,6	7,1	56971	15,4
Almagro	19418	46,5	24,6	16	72371	10,9
Almenara	23057	44	18,7	18,4	33159	11,6
Almendrales	22834	41,8	15,1	29,6	29898	14,8
Aluche	66588	48,6	28,7	19	33351	11,2
Amposta	9126	43	17,1	23,8	24314	14,1
Apóstol Santiago	15435		21,8		40604	11,9
Arapiles	2419	46,2	24,2	13,5	47995	9,7
Aravaca	27445	41,2	16,8	10,8	71212	17,8
Arcos	25354	43,3	16,8	13,5	32835	14
Argüelles	24497	46,7	24,4	16,2	56921	9,9
Atalaya	1622		23		73959	15,8
Atocha	1949	38,3	9,8	10,9	47715	18,6
Bellas Vistas	29355	43,6	18,4	25,3	34744	11,2
Berruguete	25694	42,7	16,2	26,2	32467	11,9
Buenavista	49151		13,5		35003	18
Butarque	21316	37,3	9,1	15,6	33059	21,4
Campamento	1975	45,7	22,9	24,1	34426	12,4
Canillas	39786	48,3	27,8	11,1	43396	11,7
Canillejas	29067		23,3		34162	12,5
Cármenes	17903	43,4	17	18,8	32487	13,1
Casa de Campo	12767	48,6	25,5	9,1	46362	9,8
Casco Histórico de Barajas	7384	45,2	19,9	19,8	31566	11
Casco Histórico de Vallecas	40417	42	16,7	20	27339	15,5
Casco Histórico de Vicálvaro	35519	44,1	20	22,4	27740	14,5
Castellana	16919	45	23,6	21,6	76960	10,3
Castilla	17046	44,9	22,8	11,2	62012	13,5
Castillejos	2057	46,4	23,8	16,7	49475	9,8
Chopera	19761	46,4	23	14,4	36345	10,4
Ciudad Jardín	18513	46,1	23,8	13,7	49051	12,1
Ciudad Universitaria	16364	46,1	25,6	10	65088	12,9
Colina	6569	45,3	22,9	12,1	55524	14,4
Comillas	22721	46,4	23,1	21,4	30868	10,8
Concepción	20941	47,1	24	16,4	38258	11
Corralejos	7626	39,4	10,7	7,2	72657	19,8
Cortes	10816	44,9	17,4	28,4	40008	6,2
Costillares	21914	45,3	23,5	6	70743	14,2
Cuatro Caminos	34753	45,6	22,6	17,1	48478	10,5
Cuatro Vientos	6122		7,4		38972	20,1
Delicias	28575	43,6	17,7	13	45392	13
El Cañaveral	13054	32,6	2,7	12,4	38310	22,9
El Goloso	19036	35,4	8,5	6,3	69983	28,9
El Pardo	3421	47,3	24,5	5,3	38460	11,9
El Pilar	4561	48,7	28,6	13,5	36799	10,6
El Plantío	3044		19,9		89731	19,4
El Viso	17274	44,8	22,3	11,6	83519	13,9
Embajadores	46204	42,9	13,8	30,7	30825	7,9
Ensanche de Vallecas	53208	35,2	5,5	14,3	36616	23,4
Entrevías	35399	43,3	18,4	19,5	25324	14,3
Estrella	22649	49,2	31,9	4,9	62973	12,7
Fontarrón	17333		23,6		30951	12,1
Fuente del Berro	20929	46,9	24,7	14,3	46114	10,7
Fuentelarreina	341	45,2	25,9	7,6	88753	18
Gaztambide	22959	46,8	25,4	14,3	49435	9,4
Goya	29477	46,2	24,1	18	55488	10,1
Guindalera	41964	46,4	24	12,8	51932	11,3
Hellín	9555	45	20,1	19,6	26712	13,3
Hispanoamérica	3147	46,2	24,9	8,6	70450	14
Horcajo	6339	41,7	11,3	8,2	50026	13,3
Ibiza	21492	47	25,3	14,4	52793	11,8
Imperial	22385	47,1	23,5	8,5	46721	10,6
Jerónimos	6825		26,3		71312	11,4
Justicia	18219	44,1	15,8	27	48352	7,1
La Paz	32192	50,6	36,2	5,5	61451	11,5
Las Acacias	36069	47,7	25,8	8,2	48967	9,7
Las Águilas	51268	48,5	27,5	14	32801	11,3
Legazpi	19468	40,5	11,3	8	55486	16,6
Lista	20969		24,2		56249	10,2
Los Ángeles	34827	45,7	23,1	21,9	30947	12,6
Los Rosales	37808		17,2		31264	13,5
Lucero	36749	45,6	21,6	20,4	33514	11,8
Marroquina	2612	50,1	29,2	7,7	43531	9,4
Media Legua	17323	48,6	28,7	11,6	38562	11,1
Mirasierra	35676		15,9		73969	22,1
Moscardó	26579	43,8	18,3	30,1	28875	12,4
Niño Jesús	15093	47,1	27,3	6,7	72311	14,1
Nueva España	24466		21,4		78336	16,3
Numancia	4872	43,6	18,3	26,2	27444	12,5
Opañel	33883	44,8	19,9	25	30853	11,4
Orcasitas	23085	44	19	11,1	30835	15,2
Orcasur	1439	41,2	14,4	20	28518	15,5
Pacífico	33027	48,1	26,5	10,7	46093	9,9
Palacio	23501	46	19,3	21,7	39390	7
Palomas	6922	41,5	16,6	10,3	83533	18,5
Palomeras Bajas	40477	44,2	17,8	17,4	32081	12,1
Palomeras Sureste	43162	44,3	18,7	15,2	30247	13,1
Palos de Moguer	25097		21,7		38852	9,1
Pavones	8814	48,3	27,4	11,9	36541	10,7
Peñagrande	44341	47,4	27,4	8,5	49757	13
Pinar del Rey	52031	47,6	26,4	13,5	36609	11,7
Piovera	15041	41,9	16,2	17,2	84205	17,1
Portazgo	28741		21,2		26468	13,7
Pradolongo	17878	42,2	16	38,5	24874	13,8
Prosperidad	36027	47,3	26,1	11,7	48327	10,7
Pueblo Nuevo	6284	45,6	21,6	20,7	33329	11,5
Puerta Bonita	36798	42,6	16,9	27,6	28320	14
Puerta del Ángel	43292	44,9	19,6	22,9	30717	10,7
Quintana	25469	45,7	20,9	22,5	33611	10,7
Recoletos	15444	46,6	24,4	21	79782	10,6
Rejas	17399	40	11,8	19,8	41606	18
Ríos Rosas	27163		23,5		55426	11,1
Rosas	30751	44	16,4	6,6	48314	12,3
Salvador	11202	47,1	23,1	9,7	57409	10,7
San Cristóbal	1727	38,1	10,7	37,6	22430	18,6
San Diego	45104	40,3	12,7	34,5	23954	14,7
San Fermín	23598	41,6	14,7	21,4	28655	15,1
San Isidro	40368	43,9	18,5	23,8	29019	12,6
San Juan Bautista	12445	45,2	22,7	11	62813	14,7
San Pascual	18327	47,9	27	10,6	45513	11,7
Santa Eugenia	23876		24,8		39914	11,5
Simancas	28765	42,9	15,6	21,7	34579	13,5
Sol	8164	43,5	15,8	34,8	34704	6,2
Timón	12049	40,1	12,3	10,8	45064	18,5
Trafalgar	24621	45,2	21,5	16,9	47561	9,8
Universidad	32783		16		37188	6,8
Valdeacederas	26573		14,7		31244	12
Valdebernardo	17471	43,7	14,5	9,7	42891	10,7
Valdefuentes	69176	35,6	7,9	11,5	59987	25,9
Valdemarín	7156	37,5	11,9	8,8	89731	24
Valderribas	1776		7,1		44111	22,1
Valdezarza	30484	46,4	24,9	12,9	38630	12,6
Vallehermoso	19853	47,7	27,5	8,6	63246	11,1
Valverde	64757	38,8	12,2	14,2	48350	21,5
Ventas	50218	46,3	22,2	20	31461	10,4
Villaverde Alto, Casco Histórico de Villaverde	47817	42,1	16,1	24,6	27992	15,2
Vinateros	16885	49,1	27,9	14,6	32218	11,1
Vista Alegre	47727	45,2	21,8	26,7	30153	12,1
Zofío	14382		17,5		28223	13

City in Figures.

Categorized per neighborhood

TU Delft
Delft University of Technology
Faculty of Architecture
and the Built Environment