UCCRN WORKSHOP

SITGES

HEATWAVE RESILIENCE STRATEGY: A PROPOSAL

uic barcelona

.edu

UCCRN WORKSHOP

INTRODUCTION

INTRODUCTION

INTRODUCTION

1.1 EXECUTIVE SUMMARY

Since the pre-industrial period, the land surface air temperature has risen nearly twice as much as the global average temperature. Climate change, including increases in frequency and intensity of extremes, has adversely impacted food security and terrestrial ecosystems as well as contributed to desertification and land degradation in many regions (IPCC, 2018).

This report considers the case of Sitges, a city located Southern of Barcelona experiencing extreme heat days in summer, impacting vulnerable groups, the environment, and threatening the economy based on tourism and events. The city felt the need of coming up with strategies that lead to both heat resilience design and heatwave management, to make sure that they will be able to adapt and reduce these climate change impacts.

This report contributes to the Urban Climate Change Research Network for Higher Education project (https://www.uccrn.education/), developing a strategy for Sitges addressing both short and long-term design and management solutions to heat waves, through an integrated lens. This means bridging science and planning, aligning policies and projects for a consistent climate resilience implementation roadmap. The challenge was to guide the city from its urgent need to act now through heatwave shelters toward a broader climate adaptation planning scheme, to become climate friendly in 2030.

1.1 EXECUTIVE SUMMARY

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1.3 PURPOSE OF THE REPORT

The selected public facilities and services which Sitges administration proposed as future climate shelters have been explored, examined and identified according to their strengths and weaknesses so that these can be managed and improved in the near future. This report includes the development of a framework for heat vulnerability and a roadmap for Sitges for integrating short-term and long-term possibilities as the scientific literature suggests.

1.3 PURPOSE OF THE REPORT

Indeed, in 2022 the Intergovernmental Panel on Climate Change (IPCC) introduced the definition of climate resilient development pathways, highlighting the needs to embrace a climate resilient design, including strategies, choices and actions that reduce climate change and its impacts (IPCC, AR6, 2022).
This report aim to develop through a case study an example of such a climate resilience roadmap, tacking heatwave CC impacts.

The final purpose of developing the guideline for Sitges while contributing to this UCCRN Education workshop is also to illustrate and invite all small Mediterranean cities to integrate heat-planning with other shocks and stresses (i.e. flooding, water scarcity) responses, toward a holistic climate resilience agenda, according to the idea that a long-term, multi-hazard risk management strategy, can enable climate-resilient urban transformation.

DEEP DIVE

**The Intergovernmental Panel on Climate Change (IPCC) definition of Climate-Resilient Pathways is the "Iterative processes for managing change within complex systems in order to reduce disruptions and enhance opportunities associated with climate change."*

***The Intergovernmental Panel on Climate Change (IPCC) definition of resilience is the "capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation."*

INTRODUCTION

1.4 WHO WE ARE & THE TEAM

We are a team from different European universities collaborating under the umbrella of the Urban Climate Change Research Network (UCCRN). This global network gained 15 years of research and capacity building experience, supporting cities worldwide in shaping local climate policies and innovating governance, planning and design practices. Among different regional Hubs of the UCCRN, the European one gained an Erasmus+ KA220 UCCRN_edu project titled "Urban Climate Change Research Network for Higher Education: Climate-Resilient Design, Planning and Governance of Cities". This Erasmus+ cooperation partnership was launched by world-leading Higher Education Institutions (HEIs), as Università degli Studi di Napoli Federico II (Italy) (Coordinator), Universitat Internacional de Catalunya (Spain), Université Gustave Eiffel (France), Sorbonne Université (France), Aalborg Universitet (Denmark), University College Dublin (Ireland), which include members of the Urban Climate Change Research Network (UCCRN), an international consortium dedicated to foster multidisciplinary knowledge-based cross-sectoral action on climate change mitigation and adaptation from an urban perspective. Project aims are to create an online educational platform, climate resilience boardgames, toolkits for climate resilience design and organizing a serie of workshops and design studios calles Urban Climate Design Workshops (UDCWs).

1.4 WHO WE ARE & THE TEAM

This report is the result of one of the UCCRN UDCW, hosted by the Universitat Internacional de Catalunya (UIC Barcelona - Msc. in City Resilience Design and Management), and with the participation of the University of Naples Federico Secondo (UNINA, Italy - Msc. in "Climate Resilient urban design") and 2 selected and awarded students from each of the 8 international universities taking part in the Erasmus Plus Project.

1.4 WHO WE ARE & THE TEAM

INTERNATIONAL MASTER CITY RESILIENCE DESIGN AND MANAGEMENT, UIC BARCELONA

The International Msc at UIC Barcelona is lead by the the Urban Resilience research Network (URNet) and focusing on multidisciplinary perspectives of urban resilience and sustainability. Students are introduced to the resilience of the built environment and critical infrastructures, green infrastructures resilience and community resilience modeules. After these courses, the master organizes a month long workshop addressing a case study resilience challenge, exploring the frameworks and implementation mechanisms of urban resilience. This Msc is at its 5th edition and gathing more than 50 ALUMNI from dozens of countries.

Alice Bazzica
SOCIOLOGIST

Rose Dagg
URBAN PLANNER

François Dubreuil
URBAN PLANNER

Manhoor Fatima
URBAN PLANNER

Louise Demortier
ARCHITECT

Koen Dobbelaar
ARCHITECT

Federica Lisa
ARCHITECT

Armando Natingue Jr.
ARCHITECT

Darina Hyun
ARCHITECT

Claudia Laumans
CONSULTANT

Cato Pos
SMART CITY DEVELOPER

Mailin Walther
POLITICAL SCIENTIST

Mara Owen
URBAN PLANNER

Mrinal Patil
ARCHITECT

"CLIMATE RESILIENT URBAN DESIGN" MASTER, UNINA, UNIVERSITY OF NAPLES FEDERICO II

The UCCRN_edu "Climate Resilient Urban Design" master provides methodological and technical skills to support the integration of Disaster Risk Reduction, Climate Change Adaptation, resilience and sustainability concepts within urban plans and projects, in a multi-scale perspective. UCCRN_edu master's methodology brings evidence-based approaches supported by data, models and tools will be explored, understanding limitations in the results, and ways to translate modeling and simulation results into actionable and user-friendly guidelines for decision-makers, planners and designers.

1.4 WHO WE ARE & THE TEAM

Andrea Chianca
BUILDING ENGINEER

Federica Marandino
ARCHITECT

Federica Paragliola
ARCHITECT

Martina Di Palma
ARCHITECT

Sara Verde
ARCHITECT

Milena Migliaccio
ARCHITECT

Paola Ferraioli
ARCHITECT

Martina Solli
ARCHITECT

Vittoria Russo
ARCHITECT

Sara Tedesco
ARCHITECT

Antonio Sferratore
ARCHITECT

Giuseppina Santomartino
ARCHITECT

Marion Perney
ARCHITECT
URBAN PLANNER

Nicola Addabbo
URBAN PLANNER
GIS EXPERT

Claudia Pragliola
ARCHITECT

1.5 METHODOLOGY

In this UCCRN workshop we adapted the methodology used by the Plan Integration Scorecard for Resilience for Heat (PIRSH), which assesses and improves the integration of heat reduction and mitigation strategies across community plans, while also heat equity. We also got inspired and adapted for this case study the The Rockefeller Foundation Resilience Center's Baseline Heat Risk Assessment (Rockefeller Foundation, 2020), and the Adaptation Planning and Implementation is based on the IPCC.

The framework that we created for Sitges heatwave management and mitigation structures methodologically 2 sides of heatwave responses: one is the management of heat during the day, while the other addresses the nights' heat island effect, tryint to reducein the short term, and mitigate in the longer this urban induced climate change impact. The whole report and the different methods used are structured to reflect these different adaptation strategies.

In a first part, the report presents the analysis of the city, through GIS land uses maps, analysis of plans and socio-economic data. Maps of radiant and perceived temperature with different scenarios have been developed and are described in this first part, allowing for the identification of the most vulnerable part of the city, on which our climate adaptation patway has been designed.

After the section introducing our conceptual framework, we conducted a review of the definitions of climate shelters from the literature, and built through case studies review a quick "shelters' features" assessment, composed from more then 45 indicators or functions and characteristics. This should guide any municipality to self-assess their shelters, guiding them toward a better design and management of these.

1.5 METHODOLOGY

2023, and then propose improvements for the year after and the next one, identifying a pathway toward the integration of many shelters within a city needing to think and work on these shelters connections, accessibilty and also tackling urban heat island to get rid of the need of these shelters in the middle term and relying on a climate friendly city free of the heat island effect. Jointly to these assessments and proposals for enhancing the heat shelters, we conducted semi-structured interviews to double check whether citizens are in favour of heat shelters, which other solutions and strategy they would like the city to promote and identify which are the most vulnerable groups.

In the last part of the report we developed a guideline and meta-design proposal for how Sitges should move from now to the 2030 and 2050 horizon in order to be come climate friendly and heat resilient. In this part different design and planning methods has been used starting from the integration of green (Mediterranean adapted) infrastructures, to design and management solutions for rainwater capturing and reuse, while shadowing streets, reconverting parkings into multi functional climate friendly spaces and re-shaping the waterfront.

1.5 METHODOLOGY

This last section methodology is in line with the UCCRN Education design workshops (UCDW) method based on climate data assessment and development of meta-design solutions accordingly and guided from the science driven results from the climate and context (socio-economic) analysis. More on this method available here.

DEEP DIVE

Keith, L., & Meerow, S. (2022). Planning for Urban Heat Resilience. PAS Report 600.

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CLIMATE CHANGE IMPACT

CLIMATE CHANGE IMPACT

1. ISSUES & CHALLENGES
2. CONCEPTUAL & OPERATIONAL FRAMEWORK
3. MITIGATION OF THE RISKS

2.1 ISSUES & CHALLENGES

As previously introduced, cities and settlements are constantly changing, experiencing fluctuations in population, economic activity, and political priorities. These changes, coupled with the effects of climate change, create risks for urban areas and their inhabitants. The magnitude of these risks in the 21st century will be determined by a variety of factors, including population growth, economic development, and land use change (Intergovernmental Panel on Climate Change [IPCC], 2022a) and will lead to numerous health risks affecting particularly vulnerable population groups (Heaviside et al., 2017).

Urbanisation processes have a significant impact on the vulnerability and exposure of urban populations.
When combined with climate change hazards, these processes can drive urban risks and impacts. Political commitment, strategies and scenario planning have never been more important for disaster risk management since the scale, reach and complexity of contemporary urbanisation compounds climate risks and conditions adaptation (Miller and Hutchins, 2017; Rosenzweig et al., 2018 b). The incremental rise in urban risks poses significant challenges to disaster risk management systems, especially in adapting to evolving risk profiles, shaped by expanding urban areas and changing environmental conditions associated with climate change.

DEEP DIVE

***RISK :** The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems.*
In relation to climate change impacts, risks result from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system to the hazards.
(IPCC, 2022)

2.1 ISSUES & CHALLENGES

As global temperatures increase, one key risk is heatwaves in cities which are likely to affect half of the global urban population in the future. This can have negative impacts on both human health and economic productivity. Built infrastructure such as streets and houses interact with these higher temperatures, magnifying the risks associated with urban heat. (IPCC, 2022a).

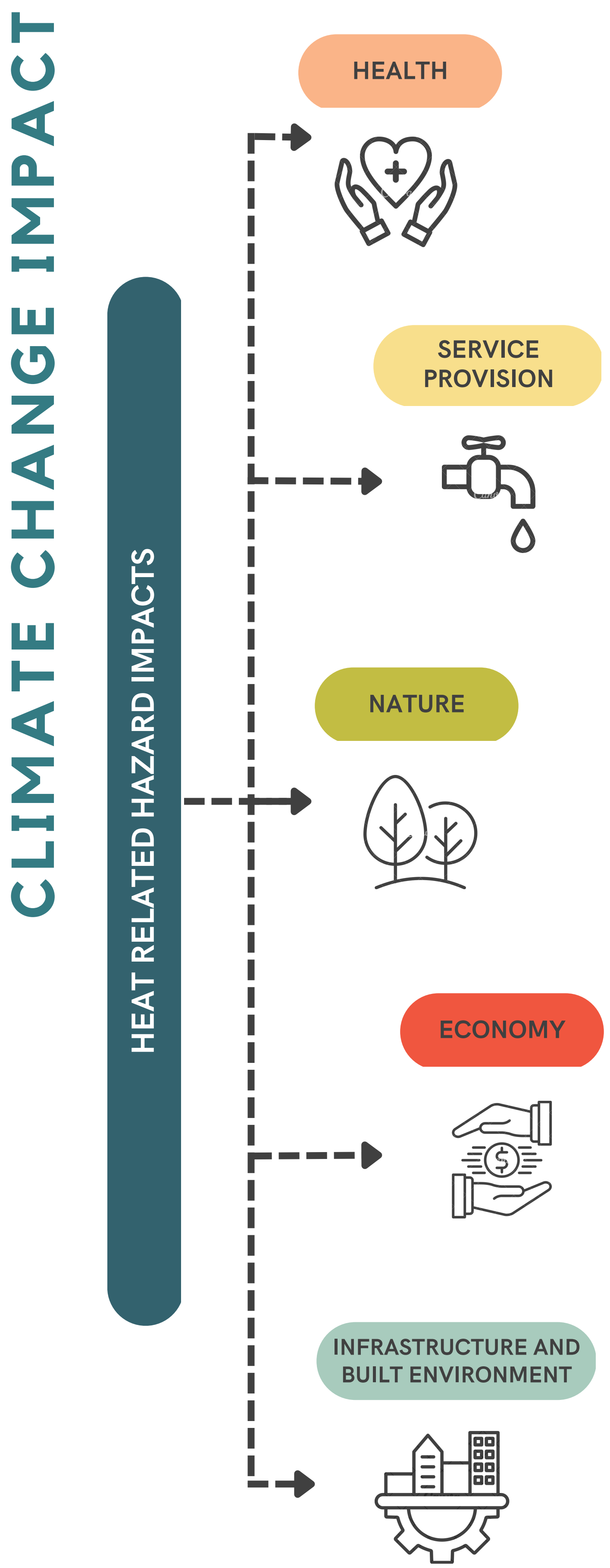
REFERENCE

SOME FACTS ON EXTREME HEAT

EXTREME HEAT IS DEFINED AS THE SILENT KILLER OF CLIMATE CHANGE

Although preventable, extreme heat has reportedly led to 1,700 deaths in Spain and Portugal during July 2022 heatwave (WHO, 2022). Extreme heat directly impacts human health and heat-related illnesses occur (heat rash, heat cramps, heat exhaustion, and heat strokes) (Meerow et al., 2022).

Cities generate "urban heat islands" due to the population density, the techniques and materials used for conventional built environment structures that retain heat instead of dissipating it. The centres of London and Paris regularly record temperatures higher than 4°C degrees as compared to the rural areas at night, while in Athens this difference can reach even 10°C degrees in summer. (Ref: EU Copernicus Climate Change Services and OECD, 2022).



2.1 ISSUES & CHALLENGES

Measuring Heat

Another fundamental aspect regarding heat perception is thermal comfort, which is determined by humidity rates, wind speed and radiant temperature (emanated by objects) (Meerow et al.).

Nevertheless, we have identified four key ways to measure heat:

- The Heat Index (HI) which measures both the effects of temperature and humidity on the human body. It is usually deployed by authorities to warn the public about risk to exposure;
- The Wet Bulb Globe Temperatures (WBGT) measures direct heat effects under sunlight. It takes into account multiple on-site factors, such as ambient air temperature, humidity, wind speed, and radiant heat to better understand human thermal comfort and use it to improve microclimate factors (like shade and ventilation).
- The Mean Radiant Temperature (MRT), which is used to quantify the exchange of radiant heat between a human and their surrounding environment, with a view to understanding the environment, with a view to understanding the influence of surface temperatures on personal comfort.
- The Universal Thermal Climate Index (UTCI), an equivalent temperature (°C), which is used to characterise the thermal stress defined by the combined influence of air temperature, radiation, humidity and wind.

CASE STUDY

Case studies on Surface Urban Heat Island (SUHI) or Urban Hotspots (UHS):
**To understand the synergies between heat waves and high mortality in Andalusian Cities:*
https://link.springer.com/article/10.1007/s41748-021-00268-9
** Land use and urban heat island in Granada:*
https://www.sciencedirect.com/science/article/pii/S2210670722004796?via%3Dihub
** Urban heat island effect in Valencia:*
https://www.mdpi.com/2413-8851/1/1/9
Barcelona urban heat island characterization and modelling:
https://eoscience.esa.int/landtraining2017/files/posters/CARBONELL.pdf

Rising temperatures do not only affect people, but also key infrastructure.
Extreme heat can cause breakages in the water supply systems due to draughts and shifting ground, leaving urban residents with no access to running water. The increased use of air conditioning causes overloading of power grids and possibly blackouts. Conventional construction materials can substantially deteriorate due to prolonged exposure to extreme heat. It became renowned for the case of Luton, UK airport runway melting during July 2022 heatwave, heavily restricting the airport capacity to operate, while in China conventional pavements reached temperatures up to 67°C, and roof material up to 90°C (Oldfield, 2018).

For this reason, it is essential to develop strategies to address these issues, such as improving access to basic services, strengthening governance and planning syst

2.2 CONCEPTUAL & THEORETICAL FRAMEWORK

2.2 FRAMEWORK

Heat vulnerability assessment

Urban environments are going through significant changes in climate patterns, including an increase in air temperature, due to the intrinsic characteristics of urban areas. This leads to a significant impact on the urban microclimate, hence the importance of addressing vulnerability (UN, 2015) since it represents the gateway for risk reduction measures (Apreda, C., D'Ambrosio, V. & Di Martino, F., 2018).

Why is it important to conduct a heat vulnerability assessment?

A heat vulnerability assessment is necessary to identify the potential risks posed by heat waves conditions to people,wildlife, and infrastructure, and to develop appropriate strategies to mitigate those risks. Heat waves can have serious health impacts, such as *heat stroke, dehydration, and exacerbation of pre-existing conditions like cardiovascular and respiratory diseases*. Vulnerable populations, such as the elderly, children, and individuals with chronic medical conditions, are at higher risk of heat-related illnesses.

A heat vulnerability assessment will be instrumental to:

- Identify vulnerable population groups in the given context and assess the potential impacts of heat on human health and infrastructure.
- Develop strategies to reduce climate impact.
- Inform public health and emergency management planning and response to heat related hazards.

DEFINITIONS

VULNERABILITY

The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

DEFINITIONS

SENSITIVITY

The degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise).

EXPOSURE

The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected.

Source: IPCC, 2022

Overview of vulnerable groups to heat
Source: (RCRC Climate Centre, 2019 p. 18)

NEWCOMES AND TRANSIENT POPULATIONS, SUCH AS TOURISTS

Language and literacy barriers, Cultural differences, such as food consumption habits, clothing choices, Unique media use patterns, Limited knowledge of local alert systems, health and social service programs

PEOPE WITH PRE-EXISTING MEDICA CONDITIONS OR DISABILITIES

May not have: access to medical services or may take medication worsening the impact of a heat wave on their condition; sufficient thermoregulating

OLDER ADULTS

May not have: access to help or be aware of extreme heat

LOW INCOME COMMUNITIES

May not have: access to heat wave warnings; access or ability to access cooling measures/cooling centres

INFANTS & CHILDREN

Relying on others for cooling or hydrating, sensitive to heat

OUTDOORS WORKERS AND ATHLETES

May not have: clear understanding of heat advisories; information on cooling centres or experience different heat coming from cooler climates

2.2 FRAMEWORK

ANIMALS AND PETS

Reliant on owners for adequate heat protection

CASE STUDY

Based on the guideline of The Rockefeller Foundation Resilience Center's Baseline Heat Risk Assessment (Rockefeller Foundation, 2020), a heat-related hazard vulnerability assessment can be conducted by first identifying several key factors that contribute to heat risk, including the urban heat island effect, the lack of green spaces and tree cover in many urban areas, and the disproportionate impact of heat on low-income communities.
The framework operates by using a multi-faceted approach to assess the risks associated with extreme heat in urban areas. The assessment involves several steps, including:

1. *Reviewing the latest scientific research on heat risks: The assessment begins by reviewing the latest scientific research on the impacts of extreme heat on human health, infrastructure, and the natural environment. This helps to identify the most significant risks associated with heat and informs the development of risk mitigation strategies.*
2. *Analysing demographic and socioeconomic data: The assessment then examines demographic and socioeconomic data to understand how different communities are impacted by heat. This includes looking at factors such as income, race, age, and access to healthcare, which can all contribute to a community's vulnerability to extreme heat.*

2.2 FRAMEWORK

3. *Mapping urban heat islands and high-risk areas: The assessment uses mapping tools to identify areas in urban environments that are particularly vulnerable to extreme heat, such as urban heat islands, which are areas where temperatures are significantly higher than surrounding areas due to the built environment.*
4. *Developing risk mitigation strategies: Based on the results of the analysis, the assessment develops a set of risk mitigation strategies designed to reduce the impacts of extreme heat on communities. These strategies may include policies and programs to increase access to green spaces and shade, improve building codes and standards, and promote public awareness of the risks associated with extreme heat.*
5. *Engaging with stakeholders: Finally, the assessment engages with stakeholders, including community organisations, local government officials, and other relevant groups, to ensure that the risk mitigation strategies are effective and equitable. This includes gathering feedback and input from stakeholders to ensure that their needs and concerns are incorporated into the strategies.*

By using this multi-faceted approach, the Baseline Heat Risk Assessment provides a comprehensive understanding of the risks associated with extreme heat and offers a roadmap for communities to build resilience in the face of these risks.

Stakeholder mapping: identify all actors to be involved in the assessment and throughout the co-design process. This exercise can be carried out in a participatory manner, with participants using snowball mapping as a method to brainstorm about the guiding questions for the assessment (purpose) and the stakeholders that will be instrumental to answer those questions. Stakeholder mapping should include at least the following categories: public sector, private sector, research and academia, civil society organisations, community representatives and NGOs.

Develop a stakeholder engagement plan to organise how and to what extent different stakeholders will be involved in the different stages of the assessment process - some stakeholders will be directly involved as partners, others may be consulted for key information and feedback, and others regularly informed of progress.

Establish a core group such as a steering committee or a project advisory group (composed of experts, citizens, municipal authorities, community reps etc.) for a transparent and inclusive review process of the different steps of the assessment (data gathering and analysis, review of outputs, integration of feedback, action planning).

Describe current vulnerability to heat events - Development of baseline information about vulnerability to extreme heat events: gather information on people's exposure to extreme heat events, identify vulnerability criteria and groups, information on people's sensitivity and (particularly those individuals with special needs or health impacts), existing coping strategies and adaptive capacity. This information should be gathered via primary data collection such as:

- Focus groups discussions, key informant interviews, direct observation during site visits and sites survey

as well as secondary data such as:

- Land surface temperature and climate analysis mapping overlaid with demographic data of age groups combined with population density (link), distribution of economic activities, green space and the built environment;

2.2 FRAMEWORK

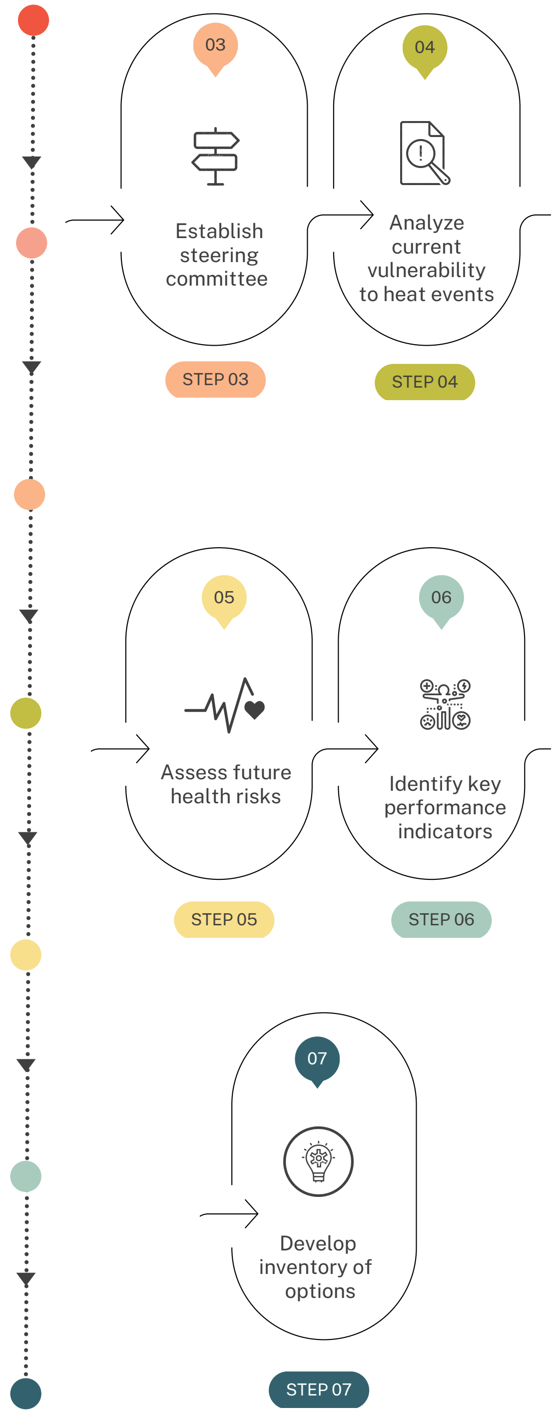
- Relative heat perception (measured via mapping of Mean Radiant Temperature but also compared with the mapping of population feedback on perceived temperature in different neighbourhoods) to examine the exposed and vulnerable population. Exposure and vulnerability across different postcodes in Sitges will also provide an appropriate reference for the city to work on heat mitigation.

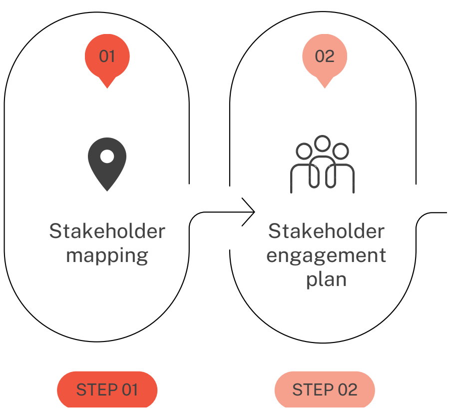
Assess future health risks associated with extreme heat events. Climate modelling of future scenarios in Sitges can be used to understand the implications of expected increases in the number, intensity, and duration of extreme heat events.

Identify key performance indicators to be integrated into the monitoring and evaluation framework (monitoring of baseline data collected as part of the assessment) and suitable time frame.

Develop an inventory of possible short, medium and long term options such as those outlined in chapters "IV Shelter" and "V Toward Resilience" of this report. The most appropriate options will be selected based on a cost-benefit analysis to then develop an implementation strategy.

VULNERABILITY ASSESSMENT ROADMAP FOR SITGES





2.2 FRAMEWORK

After learning about heat and as resulting from our site visits to the city of Sitges, we deemed as appropriate the adoption of the following framework-created by the renowned resilience scholar Sara Meerow. Furthermore, we resonate with the fact that "as average global temperatures rise, heat is increasing. This includes the frequency, length, and intensity of extreme heat events, such as heat waves, and the threat of chronic heat" (Meerow, p. 7). In fact, both climate change and the urban heat island (UHI) effect, in which the form and function of the built environment make urban areas hotter than their rural and natural surroundings, are contributing to these rising heat risks and need to be acted upon as an attempt to manage them.

For a city that aims at becoming resilient in regards to urban heat, it becomes imperative to put efforts in both preparation and adaptation strategies and formulate ambitious and achievable goals to be translated into tangible heat mitigation and heat management strategies. Especially because planning for heat resilience demands planning for uncertainty, therefore calling for "no-regret" as well as "low-regret" strategies which can be beneficial now, as well as for future climate scenarios. This also demands designing solutions with co-benefits.

CLIMATE CHANGE IMPACT

HEALTH FACTORS

Health factors such as pre-existing health conditions and access to healthcare

SOCIO-ECONOMIC FACTORS

Factors such as poverty, unemployment, social isolation and healthcare

BEHAVIOUR FACTORS

Behavioural factors such as outdoor activity levels, use of air conditioning, and knowledge of heat-related risks

ENVIRONMENTAL FACTORS

Factors such as temperature, humidity, wind and precipitation

DEMOGRAPHIC FACTORS

Age, gender, income, education level and household size are commonly used demographic

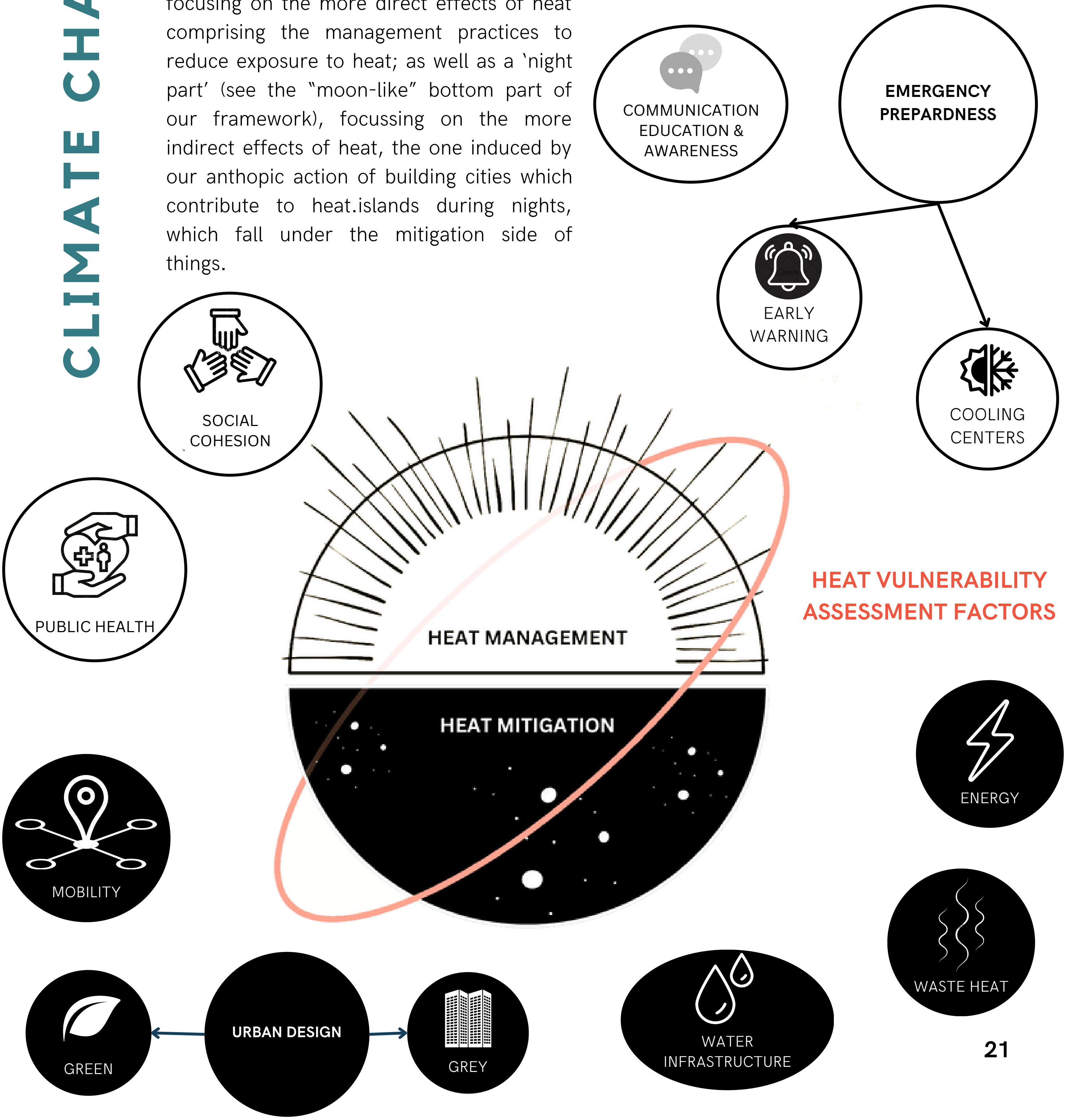
LAND USE AND URBAN MORPHOLOGY

Land cover, land use intensity, building density, the amount of green space and the orientation of streets and buildings

2.2 FRAMEWORK

- *Heat mitigation* aims to reduce the built environment's contribution to extreme heat through design and planning interventions such as land-use policies, urban design, urban greening, waste heat, water and energy;
- *Heat management* encompasses the social side of heat-risk-reduction, through emergency response, social services, communication, awareness and education and community resilience.

The proposed framework is therefore divided in two main parts, a 'day part' focusing on the more direct effects of heat comprising the management practices to reduce exposure to heat; as well as a 'night part' (see the "moon-like" bottom part of our framework), focussing on the more indirect effects of heat, the one induced by our anthopic action of building cities which contribute to heat.islands during nights, which fall under the mitigation side of things.



2.3 MITIGATION OF THE RISKS

2.3 MITIGATION OF THE RISKS

For each side, we identified key categories that need to be addressed in our actions.

On the day and management side of the framework, we envision the following categories:

Management categories:

- Public health: Should decrease mortality and morbidity and respond during extreme heat events (The function of public health in heat response is to protect and promote the health and safety of the community during periods of extreme heat. Public health professionals work to minimise the harmful effects of heat-related illnesses and deaths through a variety of strategies)
- Social Cohesion: Enhancing social links within a community to develop its capacity to face shocks and chronic stresses.
- Communication, education & awareness: The public and specific vulnerable groups need to be educated and informed about the key messages, techniques on the dangers of heat and how to avoid them.
- Emergency preparedness including contingency planning for extreme heat events and coordination between the different bodies.

Mitigation categories:

- Mobility: To meet the European Union's carbon reduction targets and create more livable cities, mobility must be addressed by promoting walkability, cyclability and accessibility to public transportation-furthermore to increase equal access to mobility, shared mobility should be promoted at a street level, as well.
- Grey infrastructure: Built shade structure, cool pavements, building and street orientation;
- Green Infrastructure: Urban greening is an integrated network system of both planned and unplanned green spaces within an urban area. Urban greening offers co-benefits ranging from cooling, shading and reducing flood risk as well as creating ecological habitats and providing psychological benefits to its users.
- Water Infrastructure: Water usage and demand increases during extreme heat events and water capacity is therefore under stress. This creates water scarcity and unequal access to potable water. As well as stress on the water features' infrastructure (both natural and constructed)

These categories will elucidate on the options and strategies to holistically tackle heat from different angles, for different vulnerable groups and holistically addressing urban heat resilience in planning.

Moreover, around the framework the factors to consider in a heat vulnerability assessment are included, with the aim to integrate within the framework the question: *resilience for whom?* In this way, addressing the various factors that influence vulnerability and vulnerable groups will create a bridge between extreme heat events and who to target through positive adaptation measures.

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SITGES CONTEXT

SITGES CONTEXT

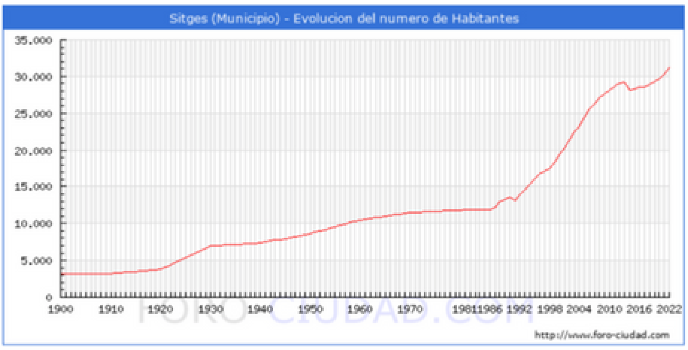
1. SITGES BACKGROUND
2. URBAN REGULATION & POLICY
3. ANALYSIS

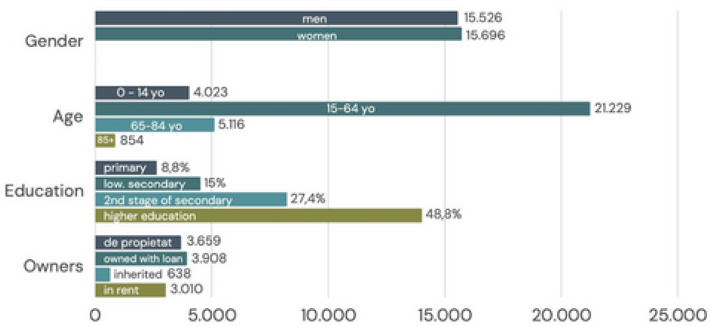
3.1 SITGES BACKGROUND

3.1 SITGES BACKGROUND

Sitges grew into a full grown city between the mid 20th century and now. It still is a refuge for citizens of Barcelona, but many tourists from Northern Europe joined as a result of the growing ease of flying into Barcelona. Currently the city has some 31.000 inhabitants and a density value of 712.0 inhabitants/km² in 43.70 km, with obviously a large difference in occupancy between the summer and the winter period. The city also attracts many one-day-visitors. It is known for beachlife, nightlife and the LGBTQ friendliness.

Sitges has experienced the fastest growing rate of annual population in the period of 2015-2020. Accordingly, almost 75% of the houses have been built (Statistical Institute of Catalonia, 2023) in the last 50 years. The population has grown over time from the area of the historic centre into the urban areas of expansion located in the north-east and west areas.





Sitges economy is mainly based on tourism, with highest turnover in August. Sitges is now the third Catalan town with the highest income and 14th in Spain (CIESIN, 2022).
The fact that the city is so dependent on tourism, also leads to vulnerability. If this economy is at risk, the effect is huge on the city.

Looking at the land use, from the historic town centre, the city has expanded, spreading intensively tower and in-line buildings until the Garraf park on the east side and pushing towards the green areas both at north (Aiguadolc district and the new developing area, even if low built) and west sides. The golf court, campings, bungalows and parkings located in Terramar stopped the sprawling of villas, resorts, and single houses typically built in the consolidated area. This so-called urban sprawl has led to a reduction in forest area and green areas. This caused a loss of habitat for many animal and plant species, as well as a reduction in the climate mitigating effect of greenery.
Looking at governance and finance, the city of Sitges is mainly focused on delivering good services to the citizens and visitors, as shows the annual budget of Sitges for 2023 with main costs for personnel and for goods and services. Next governance level is the region of Garraf, supporting its cities and villages, but also coordinating some projects

funded by the European Regional Development Fund. The governance level above that one is the Generalitat de Catalunya. At this last level is the responsibility for policies for the whole province.

For the topic of tourism there is no current policy strategy. The other most relevant policy is named: ECSCACC30, building on the international policies regarding climate change, such as the IPCC reports.
The city of Sitges has its councillor for Sustainability, Energy Transition at the moment: Xavier Roig Juan since 2019 (until this year) and is working on a Sitges actionplan (PAESC).

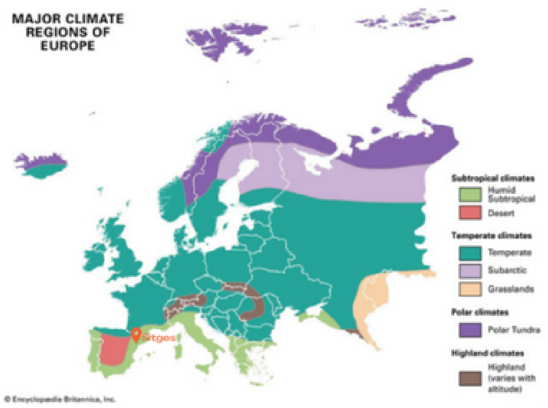
Sources of funding for investing in heat resilience could be found within the annual budget of Sitges, from Catalunian sources and even more likely from EU funding. Firstly, given the importance of the touristic sector for Sitges and the income Sitges generates from that, it could be advised to invest in sustaining the tourism given the risk of the heat. Now the city could use an investment to its advantage, positioning itself as an innovative city anticipating climate changes. Cooperating within the Garraf region, building upon previous experiences, applications for EU funds could be considered. Finally, Catalunya has options to financially contribute through the action plan.

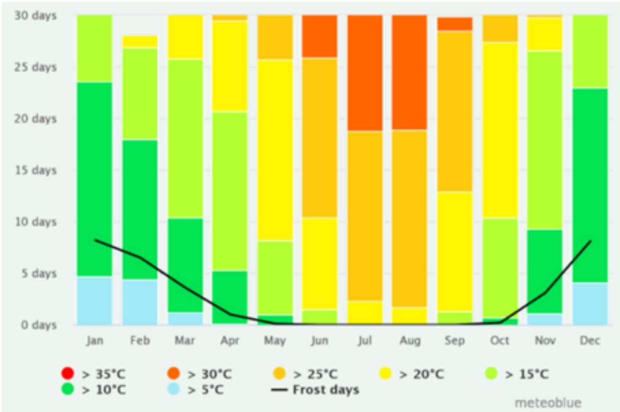
3.2 HEAT ANALYSIS

As a Mediterranean coastal town in Garraf area, Sitges' climate can be defined as a humid subtropical climate (Encyclopedia Britannica); temperatures and radiation are highly influenced by precipitation and its location close to the sea.

Apart from heat stresses, Sitges has faced floods and increasing damages from coastal erosion risks. The following map shows the flooded streets due to storm Gloria 2020: the camping area cannot adequately retain rainwater, as some of the streets that crosses both the historical centre and the consolidated area.

3.2
HEAT ANALYSIS





CIVIL PROTECTION PLAN CATALUNYA

Active drainage cone | Influence of cones | Areas at risk of sea and/or river flooding
Flooded street in flash floods storm June 2018

3.2 HEAT ANALYSIS

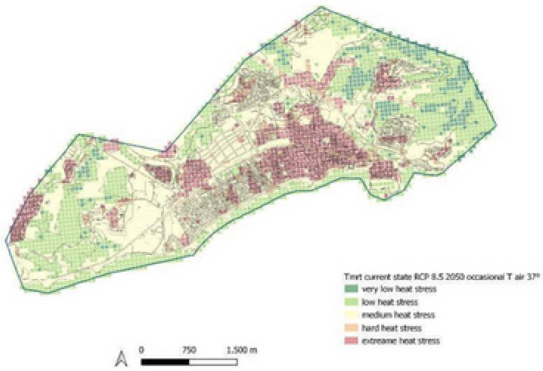
To better understand the meaning of the maps below, three different concepts should be introduced:

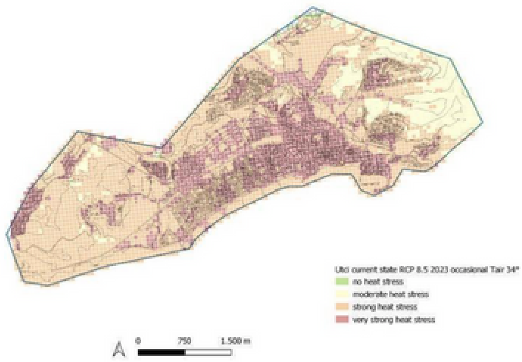
-The Mean Radiant Temperature (TMRT) is used to quantify the exchange of radiant heat between a human and their surrounding environment, with a view to understanding the influence of surface temperatures on personal comfort. Mean radiant temperature has been both qualitatively defined and quantitatively evaluated for both indoor and outdoor environments

-The aim of Universal Thermal Climate Index (UTCI) was to characterise the thermal stress defined by the combined influence of air temperature, radiation, humidity, and wind on an equivalent temperature scale (Bröde et al. 2012)

- A Representative Concentration Pathway (RCP) is a greenhouse gas concentration (not emissions) trajectory adopted by the IPCC (IPCC,2014). Although several pathways are identified, the most widely used ones are 4.5 and 8.5, which describe, respectively, a scenario in which many of the strategies are implemented and one in which no mitigation strategy is adopted.

The analysis made by QGIS software shows that the areas most affected by heat stress are the historic centre, the north-west area, the new expansion area, and the waterfront. So, we chose to model specifically those sample areas to better define their possible future behaviour as study-cases for the whole city.





The following graphs analyse both the daily average temperature and maximum temperature (in red scale), predicted for 2 p.m., as the night-time average temperature (in blue) and minimum temperature calculated using QGIS software.

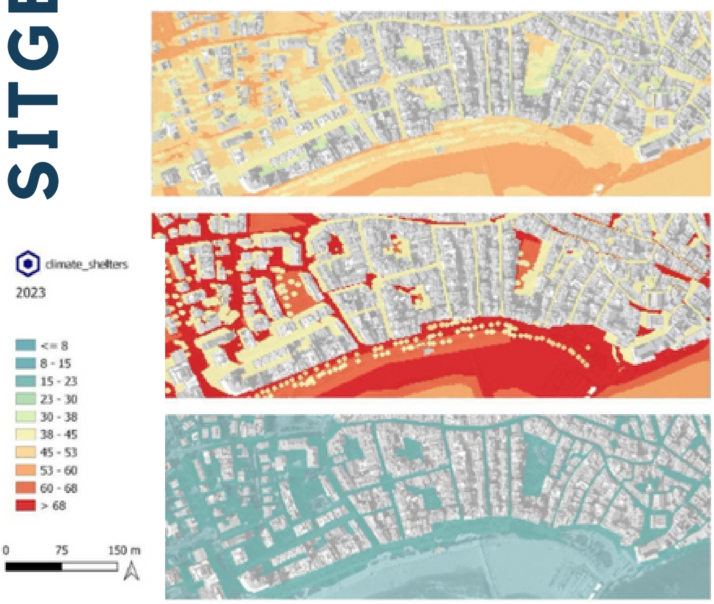
The 2050 scenario analysis shows that the situation is increasingly under pressure from the consequences of climate change. The results depict a visible critical zone due to the spread of high temperatures, to be seen as a red flag for heat risks related to the future livability conditions in the area.

SITGES CONTEXT

3.2 HEAT ANALYSIS

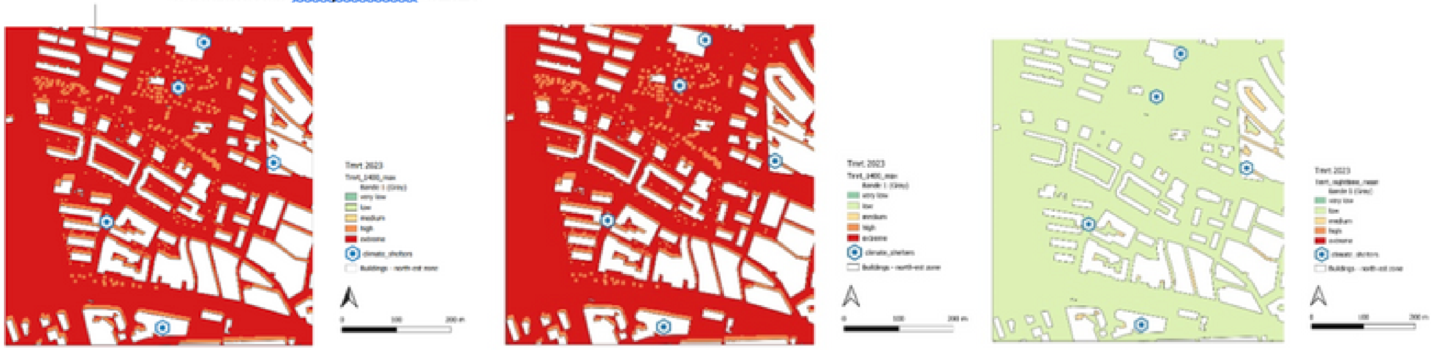
From the overlay of the previously illustrated analyses, four significant areas were identified on which solweig analyses were then done.

Two of the four analyses are given below for illustrative purposes:

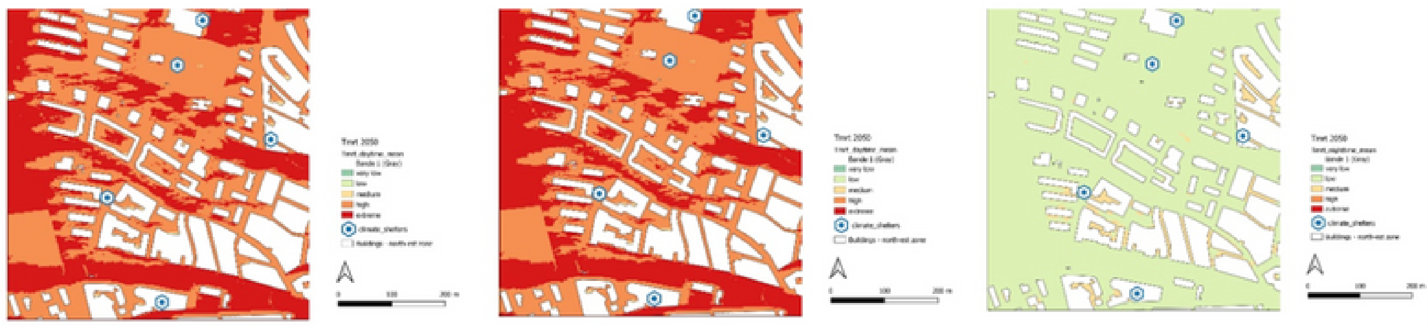


Historical center Tmrt RCP 8.5 - 2023 scenario
Occasional temperature 32.27°

Historical center Tmrt RCP 8.5 - 2050 scenario
Occasional temperature 36.65°



Climate Analysis Mapping. Mean radiant temperature during daytime for the historical centre area. RCP 8.5, occasional temperature (32,5°), 2023.



Climate Analysis Mapping. Mean radiant temperature during daytime for the historical centre area. RCP 8.5, occasional temperature (32,5°), 2050 projections.

3.3 CITIZENS PARTICIPATIONS

3.3 CITIZENS PARTICIPATION

Background

For the Sitges Heat Resilience Strategy, the implementation team conducted 24 interviews in Sitges including some with multiple participants. The purpose of the interview was to engage residents and visitors in Sitges and to gain an additional insider perspective on solutions regarding heat. The team also raised awareness of climate change through the interviews. The interviews were conducted in multiple areas ranging from the city centre, dense urban areas, the beach and near future climate shelters.

Methodology

The interviews included questions for the purpose of gaining qualitative and quantitative results. This method was suited for uncovering a wide range of views, experiences and opinions that may exist in a certain population. The interviews were conducted by one interviewer at a time. There were three interviewers available with English, Spanish and Catalan language skills, to create a structured conversation with the participants. The participants had the choice to fill in the interview online or through the interviewer in all three languages.

FIGURE 1: SITGES ONLINE SURVEY-INTERVIEW

As seen in Figure 1, for the participants, who wished to fill online with their phones were able to scan the QR code in the language of their choice. The three interviewers were also present for those who were willing to engage in person and in this scenario the interviewers had to write down their answers in the online option for the results to be available in the same format. The same questions were asked in both available options.

Interview Participants

Interview participants ranged from ages 18-84 for a wider and diverse perspective from residents and visitors in Sitges. The interviews conducted took into consideration the identified population that is vulnerable to heat in Sitges, such people with disability or medical conditions, pregnant women, elderly, low income communities, children, outdoor workers and pets. The goal was to conduct 20 interviews using QR code for the online interview method, but the result ended up being 24 interviews, with only three participants that used the online interview method. The rest were conducted with interviewers. Structure & Length

The interview consisted of 19 questions with open ended questions, multiple choice, yes & no questions and ratings questions based on satisfaction and frequency of heat related issues.

The interviewers were instructed to follow the questions as stated in the list and also were encouraged to clarify the question if the participant did not fully understand. The interviewers were discouraged in suggesting possible answers. The approximate estimated time for this interview was 10 minutes, but the majority of interviews ranged between 15-20 minutes. Interviewers were encouraged to use as much time to help the participant complete all the questions.

Method limitations

Limitations of qualitative and quantitative data are that they allow insight but they do not provide data that is statistically representative of a larger population. A data limitation to highlight is that not every single vulnerable group was able to be included in the interview such as pregnant women and people with disability or medical condition, this due to Sitges being a small city and interviewers having one day to conduct all interviews. The participants joined based on willingness to participate not necessarily on their background in Sitges or relation to vulnerable groups. Also the list of questions did not ask any female participant if they were pregnant or if they were dog owners which was a limitation of the questions in this list. The only vulnerable group addressed in the list of questions were people with disability or medical condition but the majority of participants responded with no.

Another limitation was for interviewers writing down information that was being given for open ended questions while conducting the interview. This was a risk because the interviewer could summarise the responses of participants, to ask further questions. It could also cause disturbance in flow of discussion in conversation.

The interviews included tourists, it is not fully accurate because they don't have experience in living in Sitges. Although there were exceptions, returning tourists spent months in the city.

3.3 CITIZENS PARTICIPATION

Summary of responses

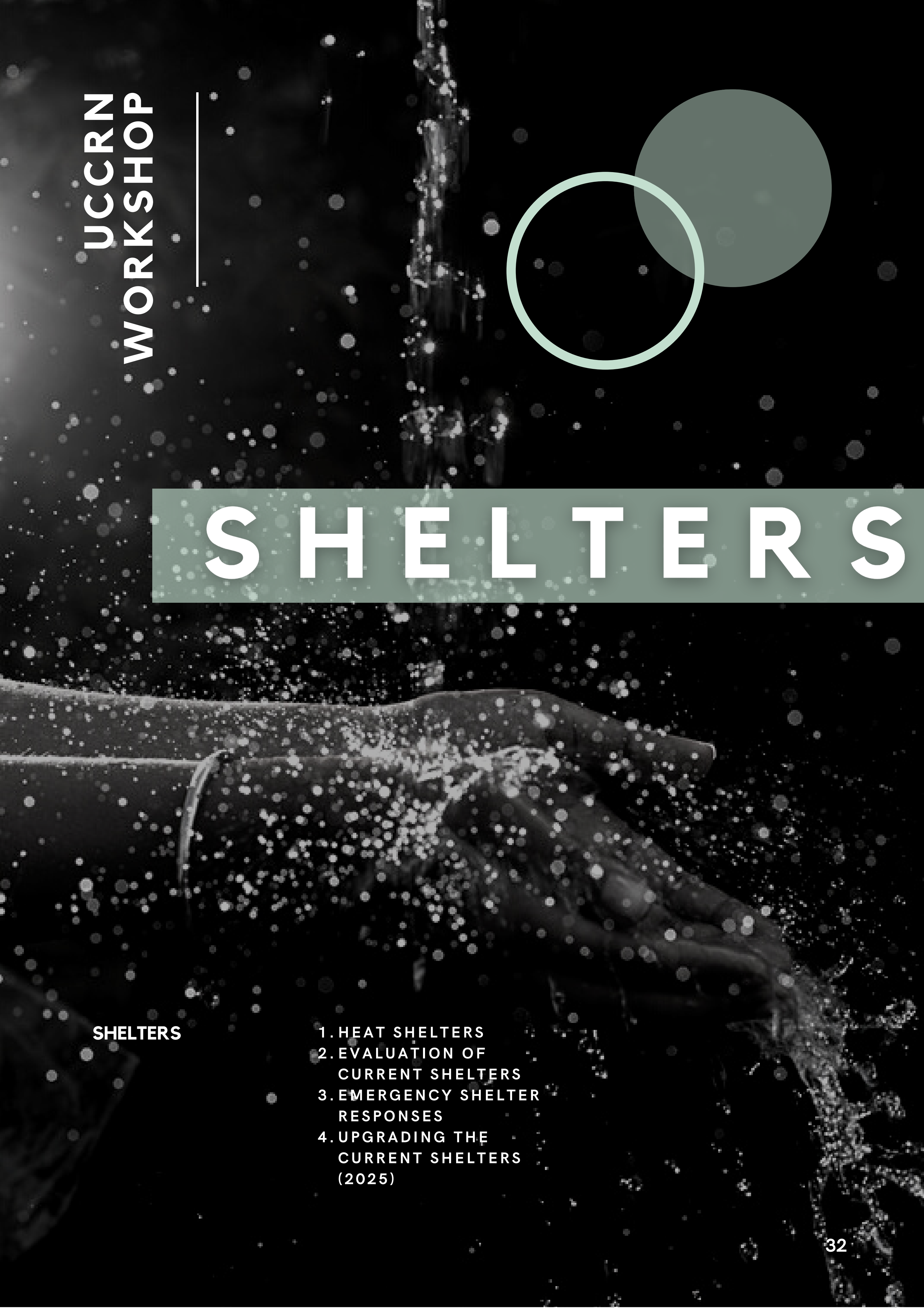
In general a range of perceptions and opinions were expressed, as a high percentage of people agreed to participate in one on one interviews. However, all participants agreed that climate shelters or another solution regarding heat were necessary before the summer approaches. One data point that we think is important, it turned out that nobody knows that there are heat shelters in Sitges, people asked us where they were located.

Perceptions

Interview participants were asked what solutions they could suggest. An example question we asked proposed solutions. Majority of participants suggested there were improvements that could be made in the city. The participants consisted of workers, business owners, street vendors, tourists and families.

These 13 responses for possible solutions are valuable as they can contribute to providing solutions. The first participant was a local perspective from a business owner who emphasized that a way to create more shade is by putting up tents on streets in the city center. The streets in Sitges are narrow so this suggestion can be easily implemented, with a material that is able to deflect the heat. Participant 2 and Participant 7 also mentioned increasing shade.

Participant 1 suggested that an existing climate shelter can be the library in Sitges. Participant 7 was from a family perspective, she suggested planting more trees in the city (in particular near the beach) and increasing green areas, such as parks or gardens. Another Participant suggested public showers on the beach because there are no public showers or toilets on the beach at Sitges.



UCCRN WORKSHOP

SHELTERS

SHELTERS

1. HEAT SHELTERS
2. EVALUATION OF CURRENT SHELTERS
3. EMERGENCY SHELTER RESPONSES
4. UPGRADING THE CURRENT SHELTERS (2025)

4.1 HEAT SHELTERS

As described in chapter 2, heat wave events may lead to physical health, as well as mental health, impacts on vulnerable populations (Yumagulova et al., 2021, p. 6). Heat shelters, which are designated cooled public buildings and/or spaces, are a common temporary emergency measure to deal with such heat wave events, as they are a relatively low-cost and easy to implement strategy that can utilize existing infrastructure and personnel (U.S. CDC, 2017). Nonetheless, the capacity of heat shelters to effectively serve vulnerable populations has been contested, commonly due to some easy-to-prevent mis-steps by the local authorities (U.S. CDC, 2017). This chapter will explore the best practices of heat shelters: Firstly by answering the question 'what should a heat shelter be?' through the use of case studies and literature review. Secondly, by condesning this literature into a tool intended to evaluate heat shelters with regards to management, as well as, design aspects. Thirdly, by making a number of future recommendations on heat shelter useful for the context of heat waves in Sitges.

WHAT SHOULD A HEAT SHELTER BE ?

Heat shelters on the inside

The most important aspect of a heat shelter is of course that it offers visitors respite and safety during extreme heat, therefore it should maintain thermal comfort during such heat events (U.S. CDC, 2017, p. 4). In Barcelona specifically, they recommend specific temperatures for optimal thermal comfort. For example, in "indoor spaces, it is recommended that a set temperature of 27°C is maintained in the summer and 19°C in the winter." (Barcelona for Climate | Ajuntament de Barcelona. (n.d.)). Nonetheless, how you actually manage to cool a certain public building or outdoor spaces has a lot to do with the design, as solely depending on air conditioning is a costly and unsustainable solution.

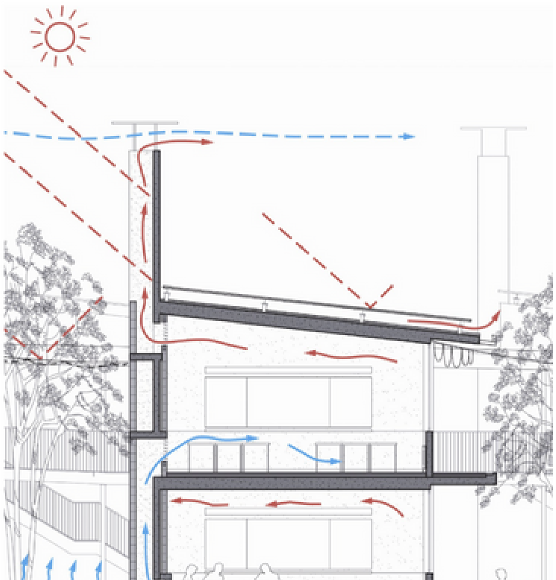
4.1
HEAT SHELTERS

Regeneration and technological retrofit actions are able to affect the reduction of greenhouse gas emissions while producing adaptive benefits. Climate-resilient design principles allow to develop strategies that can link climate risks, conditions and priorities of interventions (Raven, 2014, p.454). It is necessary to develop low-carbon and near-zero energy solutions for buildings through actions that incentivise the use of renewable systems that are integrated or applied on the existing building in order to meet energy demand. In addition, it is necessary to introduce passive systems for ventilation and for saving energy in buildings and urban greening solutions, encouraging the application of water recovery and recycling systems. Modifying the shape and layout of buildings and neighborhoods provides cooling conditions based on the control of solar radiation and ventilation to reduce energy consumption and reduce the impact of high temperatures and intense run-off (Emmanuel and Kruger, 2012, p.146). In order to ensure a multi-scalar approach, it is necessary to take into account the layout of spaces and functions within the building in order not to affect environmental strategies and to ensure the proper functionality of spaces. The choice of materials with high inertia, low thermal capacity and reflective cladding improves the performance of the building by managing the heat exchange on the surface; external floors made of materials with high albedo contribute to the reduction of the heat island effect (Santamouris, 2014, p.686-692).

4.1 HEAT SHELTERS

CASE STUDY

The badguir is a wind tower built in the city of Yazd which consists of wind sensors. These wind sensor work thanks to small pressure difference between the base and the top inside the column. When a wind passes over the tower, the warm air will rise and leave the tower while the cold air will descend directly into the city. In case you want to integrate a large island of freshness in the city of Sitges to have a refuge during the long periods of heat wave. One can imagine taking an old or abandoned industrial warehouse and retrofitting it to use it as a heat shelter. We can use the same technology that the Iraqis used with their wind towers. As a reminder, the Bagduir caught the hot winds that passed over the city and then cooled it with water to send fresh air into the city.



In Sitges, this technology can be used to catch hot air above the warehouse and send it back inside the building to create a low tech air conditioning system. The greater the height of the warehouse, the less the heat will be felt on the ground. The heat will then leave through a chimney system.

You can also ventilate the warehouse with a draft system by creating two large openings on each side. The outside wind can be cooled thanks to water points and vegetation. The trees can also create large areas of shade on the south side in order to reduce the impact of the sun's rays on the facades. Therefore, we can have a naturally ventilated heat shelter without the use of air conditioning. The excessive use of air conditioning to cool indoor places tend to make outdoor places more vulnerable with less fresh air. Inside the rehabilitated warehouse, one can think of integrating food stalls such as class stalls, smoothie stalls or fruit stalls.

4.1 HEAT SHELTERS

Thermal comfort is not the only aspect needed to be taken into account. There are certain minimal requirements that should be met for a public building to be labeled as a heat shelter. Even though there are no explicit requirements for heat shelters yet, the European Union does offer some very clear guidelines for general reception conditions, which is a good standard to meet for heat shelters as well. These guidelines are the following: Adequate space) the facility has enough space (4m(2) per person) to accommodate the required number of occupants, with sufficient furniture for seating of people / tables and chairs (EASO, 2016, p.16). Accessibility) the facility is designated to accommodate all, including those with mobility impairments, through features such as wheelchair ramps and accessible restrooms, door and passageways that are adequately wide etc. (p. 19). Heating, ventilation, and air conditioning) the facility needs sufficient cooling equipment, such as air conditioners or fans, to keep the space at a comfortable temperature during both heat waves and cold waves, while maintaining indoor air quality to reduce risks of spreading of airborne diseases, using active cooling systems rationally and moderately, prioritizing investment in passive cooling techniques, and developing low-energy cooling systems that are suited to future warmer climates (EEA, 2022, p. 8). Access to potable water) At least 2.5 liters per person per day, and this needs to be accessible 24/7 (EASO, 2016, p. 26). Sufficient, adequate and functioning sanitary infrastructure) installation and access to a sufficient number of lockable toilets, sinks (1 unit per 10 people) and showers (1 unit per 12 people) with cold and hot water, and hand sanitizing stations (p. 18). First aid) first aid kits and basic equipment are in place to ensure access to first aid in emergencies (p. 33). Other general recommendations for collective centres are: Safety) safety of occupants is ensured by the presence and functioning of emergency exits, fire alarms, and smoke detectors. Privacy / security) of occupants: availability of lockers and locker rooms for personal hygiene practices and changing, keeping personal items and valuables. Provision of information and counseling) adequate support measures, such as social counseling and information on access to public services should be available to all users/occupants (p. 35). Drinking water and food) a contingency stock of dry snacks and bottled / drinking water.

As previously mentioned, the primary function of a heat shelter is to provide respite and safety during heat waves (U.S. CDC, 2017, p. 4). Though it has been found that in many cases heat shelters remain unused during heat waves because people tend to only go to places they are already familiar with, to use the service(s) usually provided by that building or space (Berisha et al., 2017, PAGE). So the primary function of a heat shelter may be to provide thermal comfort to people, yet one should take into account a range of secondary functions (adapted to the location and/or specific needs of the targeted vulnerable population) to make a heat shelter actually function as such, because people will not feel comfortable to make use a building or space solely to seek refuge from extreme heat. For example, people will not spend multiple hours in a room where there is nothing to do, they need to have a place to sit along with some form of entertainment; this could be a movie to watch, a game to play or a book to read.

It is important to link the secondary function(s) of a heah shelter to the target population, for example, are they older or young, are they Spanish speaking or not, are they able bodied or not? These are all important questions to consider when you want to make sure that a heat shelter is actually used in times of a heat wave.

Heat shelters on the outside

Design aspects of cooling regarding the envelope involve at first building shape and mass, which determines how much of the building will be exposed to solar radiation. Buildings with less wall and roof area exposed to the sun will stay cooler. The ratio of building height to street width is an indicator of how much sunlight and radiation reaches the street and heats the air near the ground. In arid locations, it may be beneficial to place buildings closer together where they can shade each other. Shape and massing designed for heat mitigation can improve human thermal comfort, decrease energy usage, and improve airflow. (Meerow, 2022, p. 54) Provision of shade is also a critical component of heat mitigation, and it can be increased with strategically placed trees, buildings, and shading devices attached as architecture features. (Meerow, 2022, p. 55). Solar Reflectance Index is the most important roof characteristic for energy savings in warmer months, emissivity can also contribute to cool a roof. In warm and sunny climates, highly emissive roof products can help reduce the cooling load on the building by releasing the remaining heat absorbed from the sun. Another option for roof covering is solar panels, that will absorb solar energy and can provide shade underneath. Some green roofs, depending on plant selection, do not require watering and can absorb up to 70% of rain water filtration. It can combat the heat island effect, help provide insulation to reduce energy costs and help with building acoustics (Muehleisen, 2011, p.51-54). Evaporative cooling systems for facades, take advantage of evaporation of water which causes cooling of the air and water.

4.1 HEAT SHELTERS

When water evaporates in contact with an airflow without an external energy supply, there is a decrease in temperature and an increase in air humidity. Trombe wall provides the option of using passive heating and cooling to achieve the desired thermal conditions within the building. Other passive cooling strategies could be ventilated or green facades, with high thermal inertia with the capacity to store heat, conserve it, and release it gradually, allowing less use of mechanical heating and even cooling systems. (Díaz-Lòpeza et al, 2022, p. 5).

CASE STUDY

Cool Roofs - Jodhpur /Bhopal /Surat/ Ahmedabad, India

Cool roofs are one of the simplest and most cost-effective ways to fight the heat. As shown by community-led initiatives in four cities in india. Cool roofs keep indoor temperatures lower and can help decrease the dependence on air conditioners. They reflect sunlight and absorb less heat. Depending on the setting, cool roofs can help keep indoor temperatures lower by 2 to 5°C as compared to traditional roofs. This is a solution used in several cities in India to fight againt heat waves. We can find them in Jodhpur, Bhopal, Surat, and Ahmedabad.

The benefits in these cities are importants: they save energy and reduce heat stress (painting slums roofs with solar reflective paint helped keep indoor temperatures lower), help skill development of households (Mahila housing has local community workers that train the household to paint their own cool roof). This saves the labor costs and builds the household's capacity by learning the skill. The first type of cool roof is made of corrugated fibre sheets that can be installed over existing asbestos or tin sheet rooftops. According to the Mahila housing the roof remains durable for more than 25 years. The second kind of cool roof is to use reflective paint. The best coatings are usually white and smooth. In fact, that solution can be applied easily in the case of the city of Sitges. It is possible to put cool roofs on public buildings. In this way, we can imagine putting cool roof on public buildings to cool them and create some inslde heat shelters in the city.

For heat shelters to effectively serve vulnerable populations, shelters need to be and seem both available, as well as, accessibility to these populations (Yumagulova et al., 2022, pp. 22-24). Chapter 5 will explore communication and implementation strategies that could serve a wide spread awareness on the availability of cooling shelters in more detail, but what is most important is to ensure a varied outreach taking into account the targeted vulnerable populations (p. 30). Secondly, one needs to take the accessibility of shelters into account, this regards opening times (they need to be easily accessible at the times of need of the vulnerable populations which could be during the night hours or on public holidays), as well as, removing physical or visual barriers to accessibility (such as ramps for less abled people, sound and lighting taking into account adio visual sensitive people).

4.1 HEAT SHELTERS

Additionally, it is important that heat shelters not only are accessible, but also seem accessible to everyone. This regards cleary marking on street level or through communication that the heat shelter is available/open, that it is free to access, and that it contains both the necessary minimal requirements such as toilets and water, as well as, secondary function(s) such as entertainment to actually make the shelter attractive to use. When it comes to accessibility it is very important to remove all cost barriers within a heat shelter at times of heat wave events, so visitors can make use of the services provided, such as toilets, WIFI, or water.

In addition to the need to make heat shelters a welcoming place for vulnerable populations by planning for their needs, there is also the need to address wider perceptions and misconceptions of heat shelters. Some useful "lessons learned" around promoting and using heat shelters reported in a 2011 study by White-Newsome et al, included the challenge of heat shelters being perceived as "just for old people," therefore limiting other vulnerable groups from using them (Widerynski et al., n.d. p 15). Other challenges included older adults not recognizing themselves as being particularly vulnerable to heat, and not wanting to spend time in a heat shelter with nothing to do. Other considerations revolve around perceptions of vulnerable populations such as people experiencing homelessness.

"Feelings of being unwelcome or stigmatized were voiced by several participants in accessing indoor air conditioned public spaces or shaded green spaces, particularly for those who were unhoused."(Yumagulova et al., 2021, p. 9). The populations who are at the highest risk of mortality from heat, may also be those least likely to use heat shelters due to this stigma. Planning for all vulnerable populations and making spaces both inviting, attractive, and dignified is important in avoiding stigmatization of the spaces overall and them going unused in a crisis.

Heat shelters in public space

Building comfortable places to stay requires designing outside areas to offer relief during heat waves. Several factors, such as vegetation, materials used, ventilation, and shade, should be taken into account during design. Vegetation plays a big role in reducing UHI in different ways: by evapotranspiration, by reflecting the sun and by blocking solar radiation (Díaz-Lopez et al, 2017, p. 5; Taleghani, 2017, p.3). Trees intercept incoming solar radiation, shading surrounding heat-absorbing materials. This reduces surface and ambient temperatures and heat gain to buildings and other infrastructure. Moreover trees are capable of intercepting diffuse radiation reflected from sky and surfaces such as glass, cement and roofs, altering the exchange of heat in urban systems (Akbari, 2002, p.3; Shahidan et al, 2010, p.15)

As stated, plants dissipate solar radiation that they intercept through reflection, absorption and transmittance (Specht, 2010, p.9-11). The solar radiation absorbed by leaves is converted in part to heat whilst some contributes to photosynthetic energy pathways. In response to these absorbed heat loads, plants are able to cool their leaves through three mechanisms: conduction, convection and transpiration. Conduction is the passing of heat energy to the air mass in direct contact with the leaf, convection is the enhanced loss of heat energy to turbulent eddies of air (wind movement) that pass around the leaf.

4.1 HEAT SHELTERS

Transpiration is the conversion of water within the leaf to water vapour, which is then released to the atmosphere through the leaf stomata. Transpiration involves latent heat loss in the conversion of water to vapour, thus cooling the leaf and the surrounding local microclimate. Transpiration is only possible whilst leaf stomata are open to enable water vapour loss and the concurrent uptake of carbon dioxide for photosynthesis to occur in the leaves). Without transpiration many leaves will 'overheat' on full-sun, summer days, leading to damage of photosynthetic and physiological apparatus and possibly leaf loss through abscission. Evapotranspiration is the combined effects of evaporation from soil, vegetation and building surfaces, and transpiration of internal leaf water into water vapour (Hunter Block et al., 2012, p.9). These evapotranspiration processes all convert some of the sensible heat from received solar radiation into latent heat, or rather latent "cooling", as some of the heat is used up in the conversion of water from a liquid form to a vapour form (Hunter Block et al., 2012, p.15).

CASE STUDY

Urban Canopy - Toulouse, France

The Urban Canopy project in Toulouse, France, was initiated by start-up Urban Canopy, in collaboration with the city council of Toulouse and the Pont Paris Tech school.

The canopies are designed to address the urban heat island effect in the area, as well as to increase biodiversity and reduce air pollution. The installation process is self-sufficient, with a reserve supplied by rainwater and an electronic box ensuring autonomy.

A drip irrigation system is installed using sensors linked to the control box, which activates automatically when the plant is fully grown after three years. The canopies create shaded areas, which help to reduce the temperature below them by avoiding the absorption of heat by the ground. This project is a cost-effective way of improving the outside temperature and reducing air pollution while increasing biodiversity. It has the potential to be a valuable addition to neighborhood-level urban design implementations in temperate climates, such as Toulouse, France. The project cost is estimated to be between 9,000 and 12,000€.

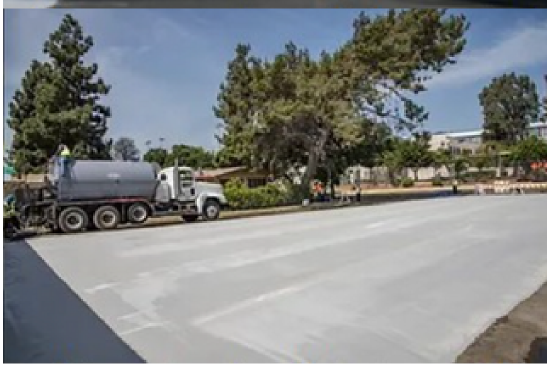
4.1 HEAT SHELTERS

Implementing paving materials for heatwave resilient outdoor spaces is crucial for reducing heat absorption and increasing comfort for users. The parameters of solar reflectance and infrared emissivity should be taken in high consideration, since SRI is the indicator of the ability of a surface to return solar energy to the atmosphere, therefore the higher the SRI, the lower the pavement surface temperature will be. Infrared emissivity is the measure of an object's ability to emit infrared energy, so the higher this parameter, then the absorbed short wave radiation is highly released as long wave radiation to the urban environment, so heat stored can be dissipated preventing pavement surface overheating. Another aspect to take in consideration should be the installation of open grid pavement, since it allows vegetation to grow through it and allows water re-use through open-cell structure (Karakounos, et al., 2017,p.9)

CASE STUDY

Cool Pavements - Los Angeles, USA
One example of the implementation of cool pavements can be found in Los Angeles, USA. The city has been experimenting with high albedo pavements as a solution to the urban heat island effect during heat waves. These pavements reflect solar energy, preventing the surrounding air from heating up and reducing ambient temperatures.

The material used in cool pavements is a mixture of sand, white and gray cements, polymers, and white pigments, which makes them relatively easy to install. However, maintenance is crucial since pollutants and use can darken the pavement, reducing its cooling effect. Despite the benefits of cool pavements, studies have also shown that they can negatively impact human thermal comfort. Nevertheless, cool pavements have the potential to create high-quality public spaces, improve air and water quality, reduce energy consumption, and extend the life of equipment, making them a valuable addition to urban design implementations for extreme heat and coastal floods.



One of the strategies in mitigating urban heat island is the implementation of blue infrastructure as it provides urban cooling through nature-based solution (Susi, 2022, PAGE). Water surfaces have a big impact on air temperature and relative humidity, since the low solar reflectance leads to the high absorption of solar radiation, without changing the water temperature (Karakounos et al., 2017, p. 2).

4.1 HEAT SHELTERS

Heat shelters in the city at large

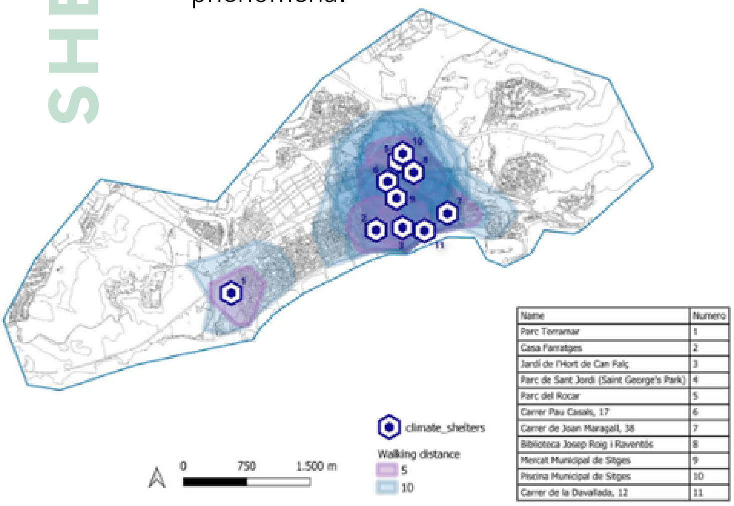
Heat shelters are only effective if they are accessible to the populations that need them. Investigations into Heat Shelters implemented in four US Cities (Phoenix, Arizona; Detroit, Michigan; New York City, New York; and Philadelphia, Pennsylvania) provide concrete evidence that it is essential that heat shelters are set up in locations that are physically proximate to vulnerable populations as well as providing safe and reliable transportation to the heat shelter. (Widerynski et al., n.d., p. 12). Here you can view a map of the planned heat shelters in Sitges:

The city can provide eleven different shelters located mostly in the historic centre and the intensive building zone of Vallpineda, apart from the one in Parc Terramar. The strategy behind the identification of those shelters is clear: in case of need, people should be no further than 5 minutes away by walking from each one. Considering the evidence from vulnerability maps (due to the age classification, to map the distribution of people older than 65 five years old and younger than 14 in 200x200 mq area) and connectivity, further considerations could be made about the need of identifying new shelters in what we defined as the consolidated area. Moreover, the mobility and connectivity in the city could suggest meaningful indications: for instance, to find places easily reachable for elderly people, even in terms of average altitude variations, is a key point.

4.1 HEAT SHELTERS

SHELTERS

During peak season, parts of the city characterised by prevalence of 2nd houses and temporary residences became densely populated with non-residents, pointing out a demographic change exactly during the warmer period, related clearly to heat island phenomena.



Name	Numero
Parc Terramar	1
Casa Farratges	2
Jardí de l'Hort de Can Falç	3
Parc de Sant Jordi (Saint George's Park)	4
Parc del Rocar	5
Carrer Pau Casals, 17	6
Carrer de Joan Maragall, 38	7
Biblioteca Josep Roig i Raventós	8
Mercat Municipal de Sitges	9
Piscina Municipal de Sitges	10
Carrer de la Davallada, 12	11

The heat shelters need to be located at a reasonable walking distance from the residential area(s) and be accessible by public transport (EASO, 2016, p. 14). An organised transportation option could be arranged to get vulnerable populations to and from the shelters (Marx and Morales-Burnett, 2022, p.14). It could be considered to make public transportation free during heat wave events as an emergency measure to remove the payment barrier of reaching a heat shelter in times of need (Yumagulova et al., 2022, p. 30). Additionally, air conditioned busses could also serve as a mobile heat shelter driving around the city.

CASE STUDY

The Oasis project in Paris, France, aimed to transform the courtyards of schools into urban fresh islands, with a focus on improving the comfort of pupils and staff, and creating a public space for local residents during the summer months when temperatures can reach up to 43 degrees.

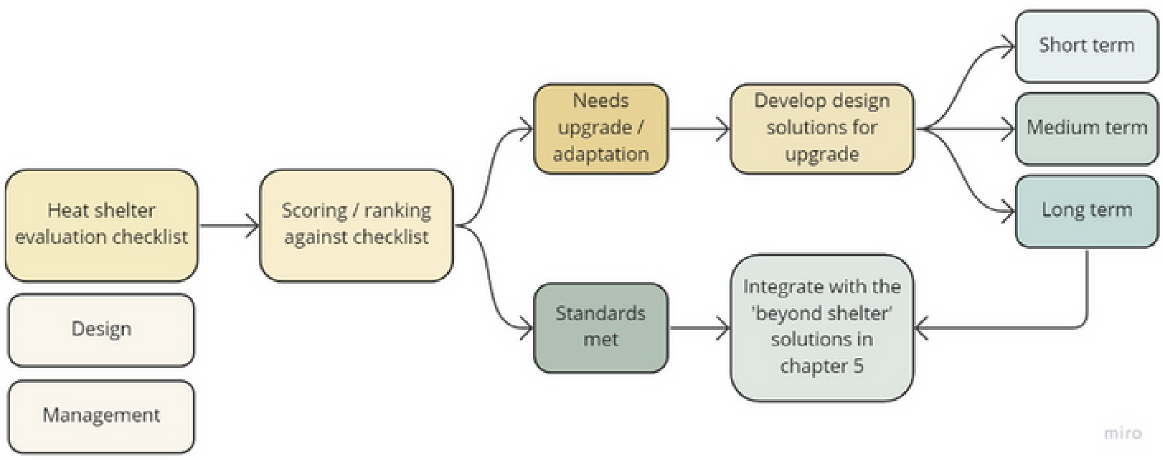
The project was part of the city's resilience strategy, which prioritized environmental issues related to urban heat islands. The project involved workshops and consultations with students and residents to develop a co-construction approach that addressed people's needs and raised awareness of climate change and heat waves. The project was funded by the European Union and the European Regional Development Fund. The direct and indirect benefits of the project included improvements in outdoor thermal comfort, increased biodiversity, and better management of rainwater to mitigate the effects of flooding and drought. The courtyards of schools and colleges, covering more than 70 hectares, were considered critical for implementing measures to address the hazards of urban heat islands, flooding, and drought.

Heat shelters should also be managed in a way that acknowledges the wider environment around them and possible compounding effects, these are additional shocks and stresses that result from an initial shock or stress. For example, a study done over the 2021 heat waves in British Columbia they found that compounding effects of pandemic restrictions on heat shelter hours, holiday closures over long weekends, & wildfire smoke impacted access to heat shelters during some of the hottest days of the heat wave (Yumagulova et al., 2022, p. 27). Another lesson learned from this study is that existing emergency management plans can and should be adapted to address the effects of multiple risks at the same time such as flooding and extreme heat simultaneously.

4.2 EVALUATION OF EXISTING HEAT SHELTERS

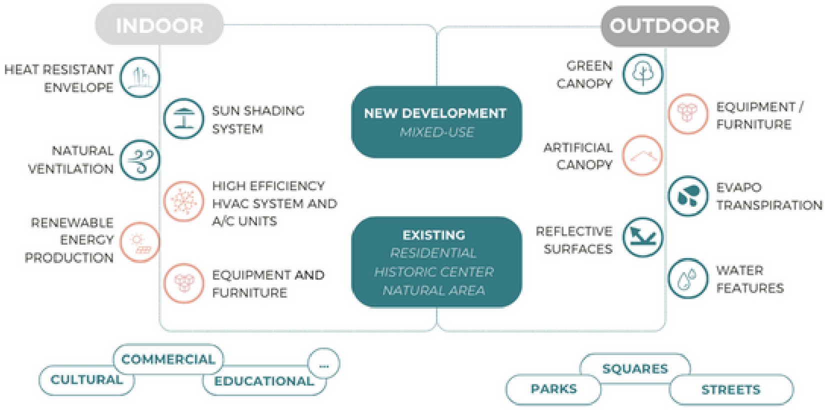
In this section we will explore the evaluation tool developed to be used for a self assessment of heat shelters in Sitges. The evaluation tool can be used to evaluate the design and management components of heat shelters: A scoring system is applied to each answer (positive answers scoring 1 and negative answers scoring 0) and a total scoring for each case is provided at the end of the evaluation exercise, so that the overall performance of heat shelters can be ranked against the proposed checklist. Based on the scoring range, the evaluation exercise will identify those heat shelters that meet the requirements and standards and can be integrated with broader heat mitigation solutions proposed in chapter 5, and those heat shelters that will need upgrade and adaptation interventions. A template evaluation checklist is provided below with an example application of this methodology for the case of Sitges.

Heat Shelter Evaluation - process flow chart

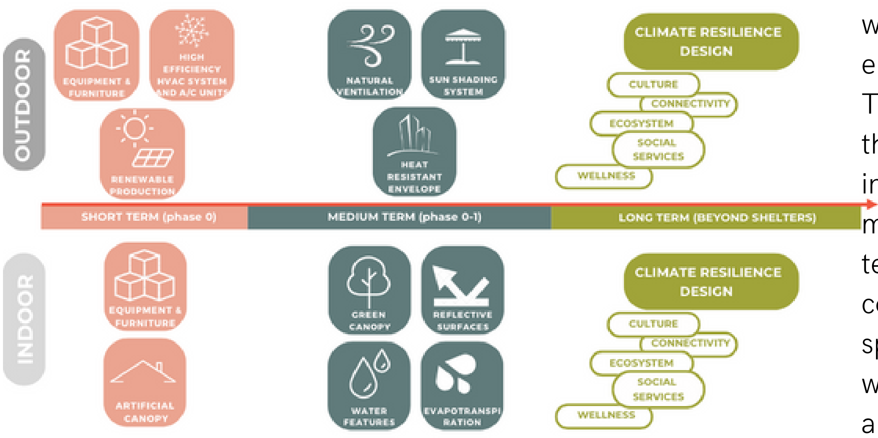


4.3 RECOMMENDATIONS & THE WAY FORWARD

A project strategy that integrates heat mitigation and adaptation measures, in the form of design and management strategies over the short, medium, and long term can be developed and expanded starting from the proposed diagram below (fig.1).



The diagram shows different interventions to be adopted for new developments or existing structures, applicable for indoor or outdoor spaces, linking these areas to commercial, cultural, educational destinations as well as existing parks, squares and streets. These interventions are color coded according to the temporal phase in which they can be positioned on an implementation timeline as per diagram below (fig.2).



The short term (phase 0) refers to solutions that can be adopted starting from the summer 2023 such as: Equipment and/or furniture; HVAC systems, A/C units and renewable energy production; Artificial canopy. The medium term (phase 1) refers to solutions that can be adopted up until 2025 such as:Natural ventilation; Sun shading system; Reflective surfaces; Heat-resistant envelope; Green facades and green canopy; Water features. The long term (beyond shelters phase) refers to the climate-resilient urban design approaches proposed in Chapter 5 of this report, which aim to propose a climate-resilient design approach going beyond temporary solutions to single problems and considering climate change as a systemic and integrated issue.
This approach takes also into account the co-benefits that each solution can provide (fig.3-4). As stated by Leone and Raven (2018), the climate-resilient transformation of cities requires a multidisciplinary approach that combines the forecasting approach of climate science and risk studies with the holistic perspective of urban, environmental, and technological design.
The project aims to bring to life a vision for the future of urban areas. This vision involves combining medium- and long-term mitigation/adaptation strategies with short-term social, economic, and environmental co-benefits, all with the goal of addressing specific needs for urban regeneration. This will be achieved through careful assessment and prioritization of design alternatives, resulting in the shaping and phasing of feasible and desirable scenarios.

SHELTERS

4.3 RECOMMENDATION & WAY FORWARD

The short-term conditions limit the scope of design to a few basic elements, such as the design of a heat shelter that only addresses immediate heat-related issues, without taking into account the systemic benefits of a climate resilient approach. It is important to adopt a more holistic perspective that considers the long-term consequences of design decisions and incorporates the co-benefits of different solutions, even in the short term. This approach can lead to more effective and sustainable urban design strategies that address both immediate needs and long-term challenges.

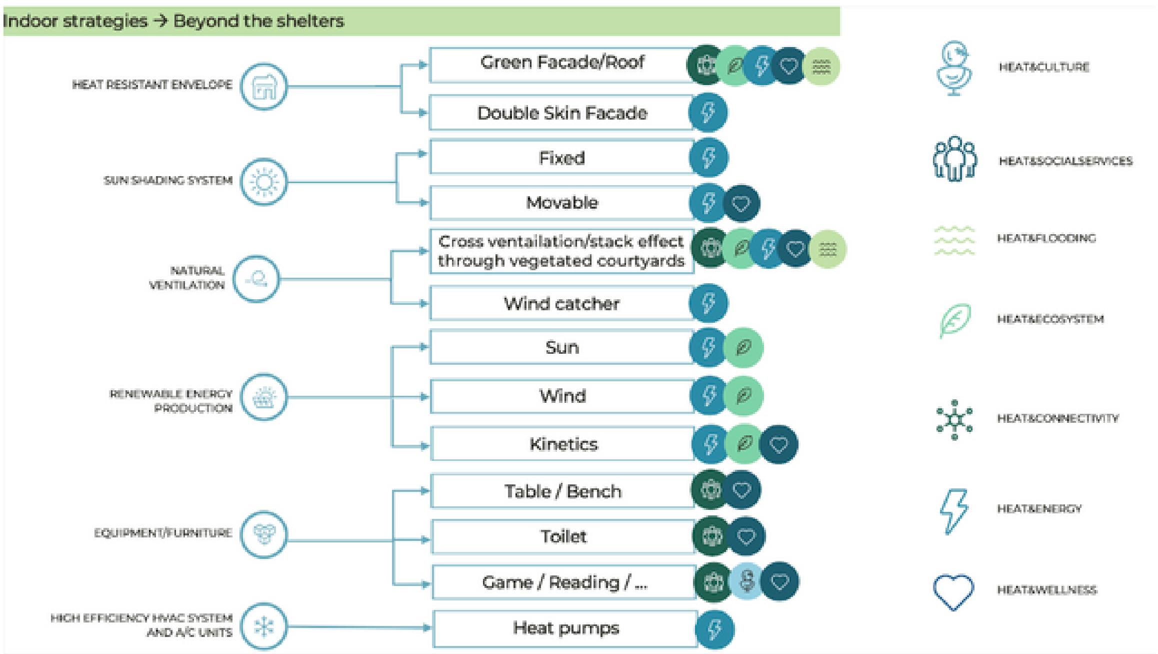


Figure 3

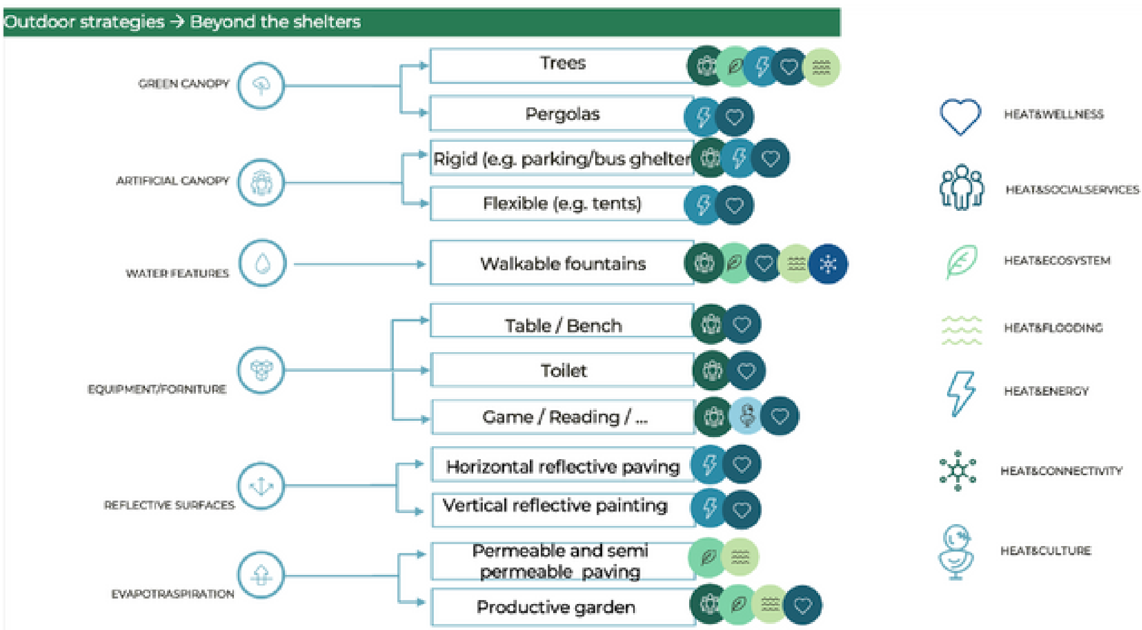


Figure 4

4.3 RECOMMENDATION & WAY FORWARD

For the upcoming summer, due to the limited time and resources available it is best to aim for the best balance between quantity, resilience and quality of interventions to manage and mitigate potential heat waves in existing heat shelters. Some recommended rapid actions / quick fix options are provided below:

1. Air conditioning is a common solution to provide cooling to indoor spaces during heat waves. However, it is not a sustainable solution as it consumes a significant amount of energy and exacerbates climate change by increasing GHG emissions. Furthermore, the peak of energy demand from air conditioning units during heat waves is likely to overload the electricity grid, causing blackouts and power outages. Instead of relying solely on air conditioning, sustainable solutions such as using natural ventilation, planting trees for shade, and reducing overall energy consumption should be considered to combat heat waves.
2. Artificial canopies can provide additional shading in heat shelters and courtyards. Low-cost and low-tech solutions most commonly used are shade awnings frames and shade covers such as tarpaulins in UV-resistant PVC.
3. Cool roofs can reduce the indoor temperature in a building by 5 °C by applying heat reflective paint on the roof cover.
4. It's also possible to install solar PV panels and use sun energy to cool down some buildings with HVAC and AC units.. Solar powered AC units may require a considerable upfront investment due to the high purchase and installation costs, with a return of investment in a few years time due to the consistent reduction of energy bills and surplus energy produced.

5. Adding equipment and furniture such as tables, chairs, benches and similar to allow heat shelters users to rest while spending time at the shelter, to make use of the space for secondary purposes such as reading, entertaining, working or socializing and at the same time, to make the space more comfortable and usable at times of increased demand and emergency.

6. Depaving is an option to prevent surface overheating by removing conventional hard surfaces, pavers and paving materials such as asphalt and concrete flooring in open areas and replacing them with alternative materials such as gravel or soil that allow water to soak through and evaporate.

Figure 5

These six options can easily be combined to improve the results and offer more comfort in heat shelters.

SHELTERS

Based on the analysis of heat risk maps it is possible to identify the areas of Sitges with the highest density / percentage of vulnerable population and high heat stress values, therefore this information can be used to identify the heat shelters that need priority investment to meet the needs of these groups in their neighbourhoods. The high risk areas identified include four main heat shelters:, Casa Farratges, Jardí de l'Hort de Can Falç, Biblioteca Josep i Roig,, and Carrer Pau Casals, 17 as per figure 6 below.

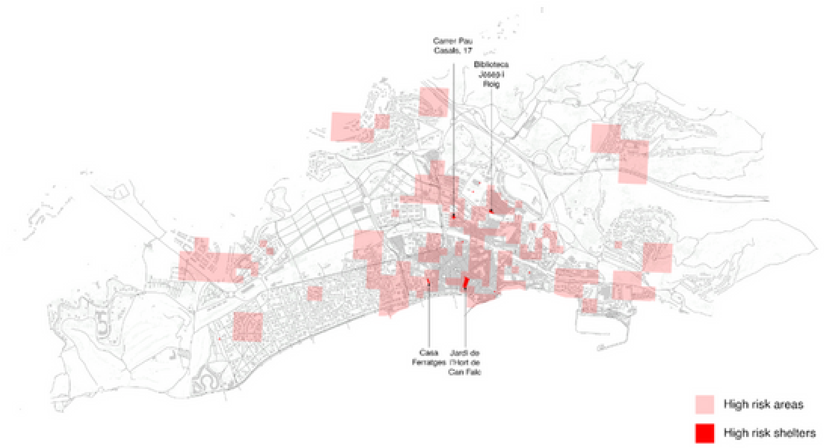


Figure 6 - Sitges heat risk map

4.3 RECOMMENDATION & WAY FORWARD

Integrated heat mitigation approach

However, simply implementing heat shelters may not be enough. It is crucial to develop short and long-term integrated plans that not only consider the design implications of the facilities but also provide a list of cross-actions to ensure that the facilities are effective and functional throughout the year. This requires the involvement and education of the users of the facilities to ensure that they are utilized effectively. To achieve this, it has been necessary to categorize possible actions and effects based on their impact on the domains of wellness, social services, ecosystem, connectivity, and culture.

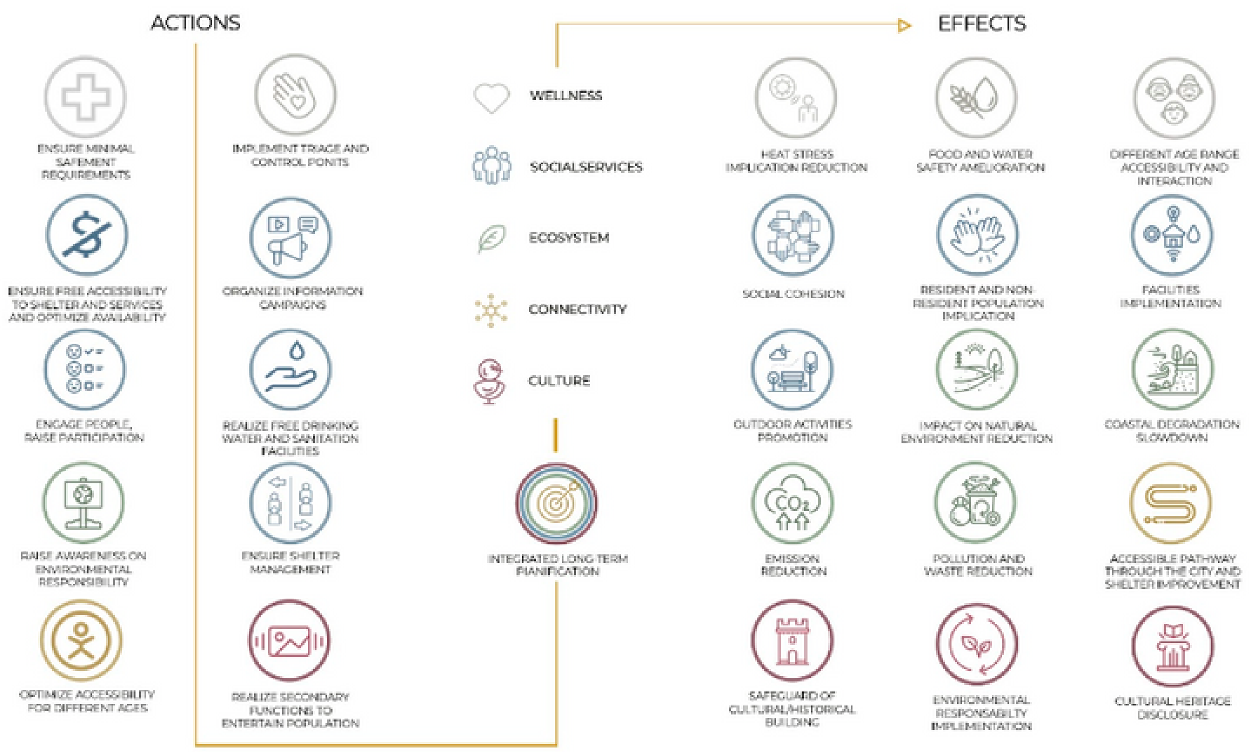


Figure 7 - *Scheme of the actions and possible effects and their category of interaction*

4.3 RECOMMENDATION & WAY FORWARD

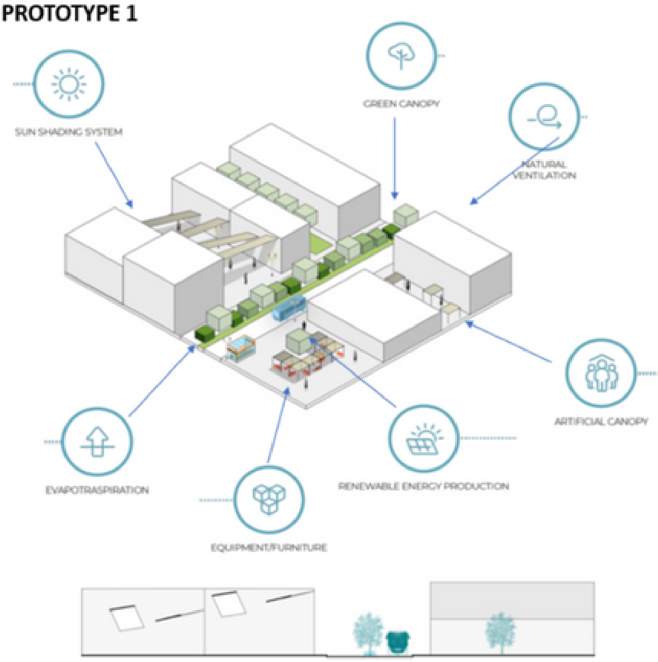
This categorization and scheme provides guidelines for management and allows for considerations and prompts to plan future interventions and progress. By adopting an integrated approach that considers these domains, the city can adapt to climate change and embrace new services as an integral part of a more sustainable approach to urban growth and development.
The holistic approach to address the impacts of climate change and development step by step, will address the city of Sitges to become more resilient and better prepared to face the different objectives, the evolving phenomena and relative challenges of the future.

The following are key recommendations on how to adopt an integrated management approach:

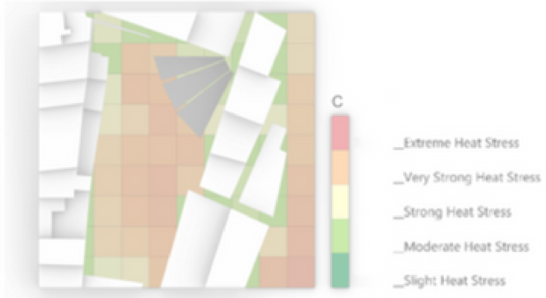
1. Firstly, it is necessary to determine the effects of extreme heat on the physical and psychological health of the population, who can find relief from extreme heat and be assisted by medical personnel in the heat shelters.To this end, it is advisable to provide first aid and/or triage points within the facilities, allowing immediate assistance or referral to nearby hospitals. This type of service is part of those that can be defined as minimal safety requirements to deal with heat related morbidity.
2. In order to ensure safety at all times during peak of demand and influx of visitors during an extreme heat event, it is necessary to have fire safety measures in place such as fire alarms and smoke detectors, sprinklers/ fire extinguishers, emergency exits and evacuation routes, etc.
3. Access and permanence in the facilities must be guaranteed all day and free of charge to everyone without discrimination.
4. Conduct outreach and education efforts to raise awareness about extreme heat, and the presence and relevance of heat shelters. In this scenario it is crucial to plan information campaigns on risks to make the population aware of the actual possibilities offered by heat shelters, as well as access conditions and services offered.

5. Such initiative should be complemented with awareness-raising campaigns on environmental responsibility that imply reducing consumption and proper waste management to act in the long term on the causes of extreme weather events and allow the city of Sitges to participate in achieving the decarbonization targets set by European plans by 2030.
6. Adequate funding and resources must also be allocated to ensure that these facilities are built, maintained, and staffed properly to meet the needs of the community.

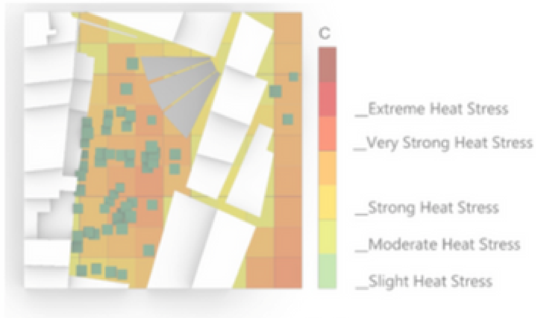
PROTOTYPE 1



AFTER INTERVENTIONS **SIMULATIONS**

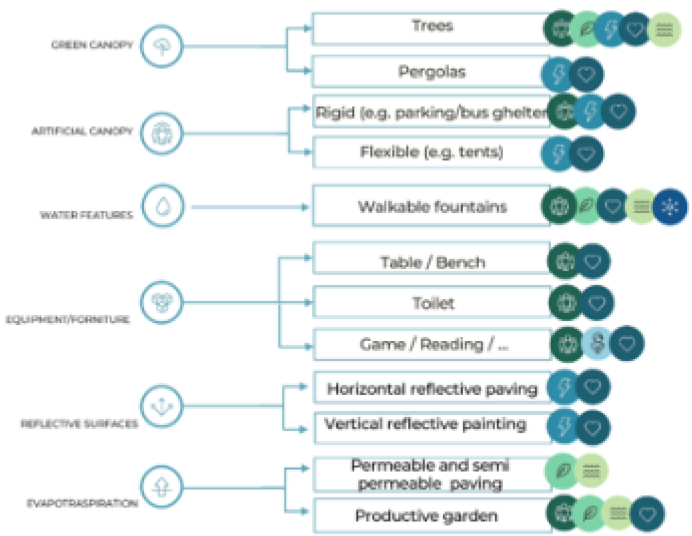


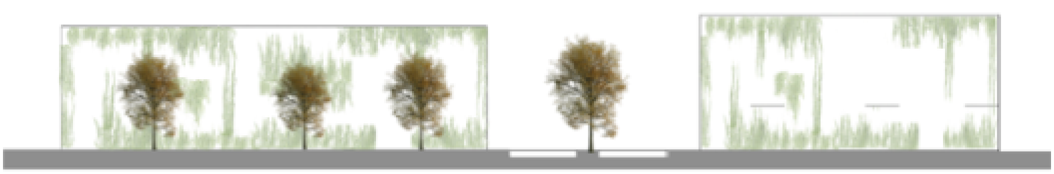
Mean Radiant Temperature
05 Aug 14:00

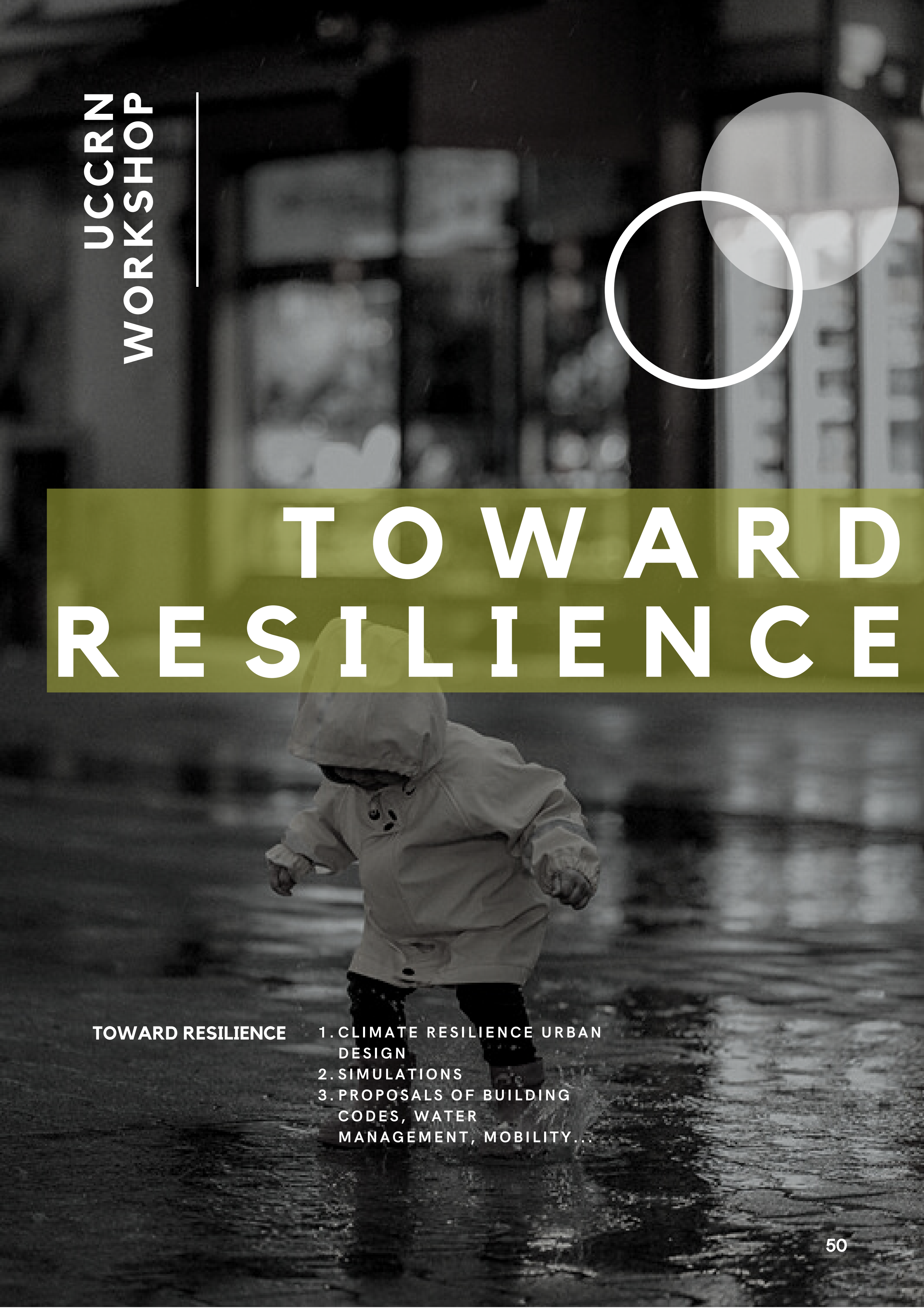


Universal Thermal Climate Index
8/5 to 8/5 between 12 and 18 @1

JARDÍ DE L'HORT DE CAN FALÇ **SHELTER STRATEGY**







UCCRN WORKSHOP

TOWARD RESILIENCE

TOWARD RESILIENCE

1. CLIMATE RESILIENCE URBAN DESIGN
2. SIMULATIONS
3. PROPOSALS OF BUILDING CODES, WATER MANAGEMENT, MOBILITY...

5.1 INTRODUCTION

In this section, we present a comprehensive approach towards preparing Sitges for the effects of climate change, building resilience rather than focusing exclusively on emergency response. Adopting an integrated approach through public policies and management is essential for creating a heat-resilient city able to live alongside the challenges posed by climate change. Whilst heat shelters are effective in emergency situations, they represent a small part of a larger heat resilience strategy. To this end, we propose a range of medium and long-term solutions that aim to reduce the vulnerabilities of Sitges to climate change. Our objective is to create a coherent policy program that can mitigate the effects of climate change on Sitges' economy, social cohesion and public health, and ecosystem.
One critical aspect of climate change is the Urban Heat Island (UHI) effect, which is primarily driven and exacerbated by the built environment. Therefore, it is necessary to implement strong mitigation policies to ensure reasonable temperatures in Sitges, taking into account the predictions for climate evolution in the coming century.
This chapter explores the best practices for heat mitigation. We will focus on rapid and low-cost solutions created by grey infrastructure, followed by proposed adaptations to water infrastructure. The next section will cover proposals to create a bioclimatic city using green infrastructure and will seek to address mobility issues. These proposals will be assessed along the lines of estimated costs, stakeholders' involvement, co-benefits, and KPIs.

GREY INFRASTRUCTURE
This first sub-section focuses on the "grey solutions" that can limit the urban heat island effects. The set of solutions presented in this part can be implemented in the short and medium term in Sitges.

5.1 CLIMATE RES. URBAN DESIGN

If the grey infrastructure in Sitges is poorly designed or engineered, it will exacerbate the summertime urban heat island (UHI) effect. Sitges is currently struggling with urban heat, and with rising temperatures and droughts caused by climate change, swift and strategic adaptation, and mitigation are necessary to prevent the situation from deteriorating further. Proposed alterations to buildings and streets provide possible solutions to Stiges' UHI issues.

COOL ROOFS
Roofs are the only part of the building which is directly exposed to the sun for the entire day, which makes it prone to absorb a lot of heat during hot summer days depending on the roofing material or the shape of the roof. A Cool Roof minimizes solar heat gain keeping roof surfaces cooler under the sun. A cool roof is designed to reflect more sunlight than a conventional roof, absorbing less solar energy. This lowers the temperature of the building just as wearing light-colored clothing keeps you cool on a sunny day. It allows to reduce the temperature inside the buildings, and aims to lower the energy consumption from air conditioning devices for instance. Combining this solution with a map that lists households that have socio-economic difficulties may help to prioritize where it should be implemented.

Example: Melbourne, Australia (Cool Roof Guide), New York City, USA (Cool Roofs Initiative)
Cost: €
Maintenance: Easy to Medium
Stakeholders: Municipality, Building owners
Co-Benefits: Thermal Comfort, Reduction in Energy Consumption

FACADES
After roofs, facades are also exposed to heat especially the ones that are oriented toward the south. Two kind of solutions can be implemented:

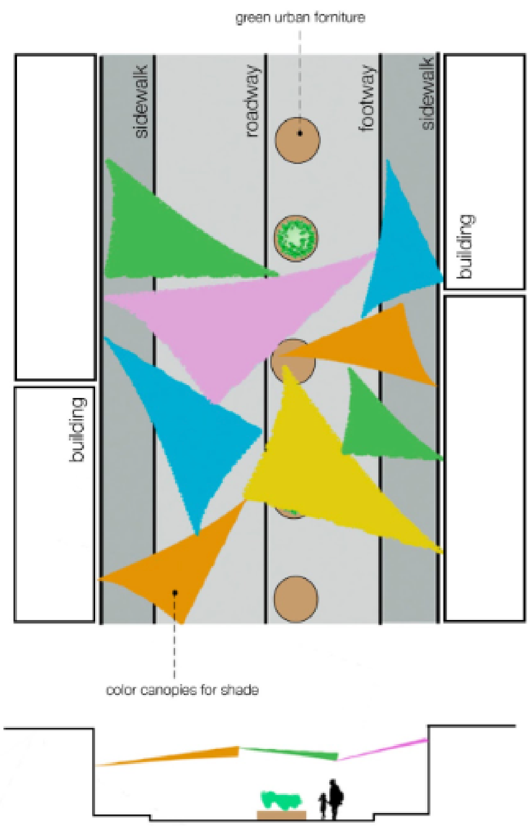
- Non-structural facades and outside window shades that can be move according to the trajectory of the sun. It can benefits by reducing building warm-up and lower cooling energy needs.
- Green facades with drought-resistant plants offer additional benefits. However, implementing facades in Sitges is complicated due to local building codes, particularly in the protected old center.

We recommend adding those kind of facades in the local urban plan for new urban projects.

Example: Council House 2, Melbourne, Australia
Cost: €€
Maintenance: Medium
Stakeholders: Municipality, Building owners
Co-benefits: Thermal Comfort, Reduction in Energy Consumption, Biodiversity

Pedestrian ways, Public Spaces, and Plazas
The City of Sitges has more Hardscape than Softscape which is one of many reasons for the urban heat island and thermal discomfort in the city.
Street shading
Shading streets and open areas from the direct sun can lower local microclimatic temperatures; reducing heat stress on pedestrians, buildings, shop fronts, and vegetation. Priority areas can be identified using shadow and temperature maps whilst taking into account function. Priority areas will include busy streets and the main beach promenade. Installing "solar sails" is a low-cost and low-maintenance solution to provide immediate relief from the urban heat.

Example: Szeged, Hungary (2023)
Cost: €
Maintenance: Low
Stakeholders: Municipality, Building ownersCo-*benefits*: Thermal Comfort, Reduction in Energy Consumption, Walkability



GREEN CORRIDORS
This solution requires the replacement of hard and sealed surfaces with partial soft scapes. The renovation allows heat reduction through evapotranspiration, increased biodiversity, improved public space functionality and use, and increased access to green spaces.

Example: Barcelona's Green Corridor, Spain, Washington DC's Program
Cost: €€ - €€€ (Medium to High)
Maintenance: Medium
Co-Benefits: Thermal Comfort Creating a comfortable microclimate, Biodiversity, Walkability, Stormwater Management

CLIMATE RES. URBAN DESIGN

5.1

WATER MANAGEMENT

Sitges has a Mediterranean climate with cool winters and hot summers. Rainfall is scarce but intense, with July being the driest month and September and October having the highest rainfall. The Spanish Meteorological Agency notes that sporadic intense rainfall events cause pressure on the drainage system, causing runoff that pollutes the sea and damages tourism.

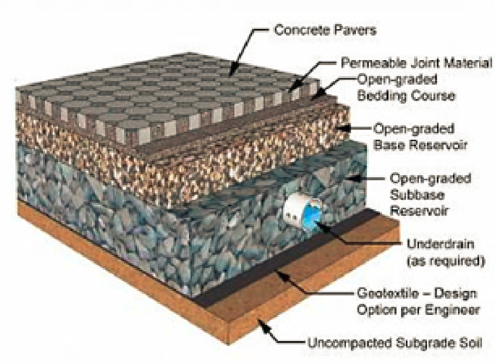
To address water scarcity, the city can implement measures to capture and reuse rainwater. Harvesting and capturing systems can collect rainwater for use during the driest months, storing it underground reservoirs for irrigation. These solutions can improve the city's water infrastructure and contribute to its resiliency.

The map illustrates a breakdown of land cover in the Sitges urban area, which is estimated to cover 365 hectares. This space is dominated by the Green cover (38%), of which nearly half is classified as agricultural land. There are 1300 buildings in the study area which cover 67 ha (21%). This suggests the impermeable surface cover is approximately 62% of the study area. Finally, tree canopy cover (which is above the urban surface) represents 13.5% of the study area. For these reasons, we deem it necessary to propose interventions that will tackle the issue of the impermeability of the city’s streets. By making urban surfaces more porous other benefits will follow, such as limiting surface runoff, as well as harvesting rainwater to maintain the urban canopy without resorting to freshwater consumption. On the other hand, a proposal for water-saving equipment at the domestic level will be proposed.

RAINWATER MANAGEMENT

Surface runoff

Soil artificialization leads to runoff and micropollutants in rainwater, particularly in city centers. Increasing surface permeability through special pavement or green corridors (as we saw above) can allow for infiltration, retention, and reuse of rainwater, reducing pollution concentration by up to 70% (Roulépur, 2018). This intervention can take place on roads and parking lots, with certain materials like minerals or foams providing greater filtration. Replacing pipes during street renovations can reduce the freshwater wasted of 20% due to pipe conditions in Spain (INE, 2014). A monitoring system can identify leaks and provide information on the city's flow rate and consumption.

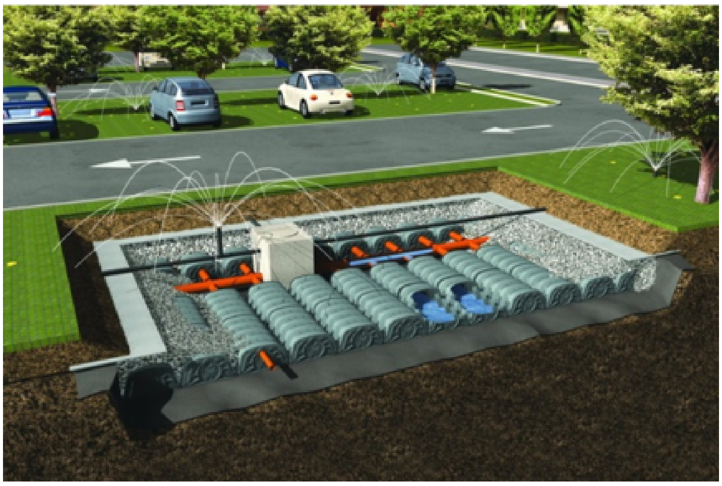


RAINWATER HARVESTING

Rainwater harvesting in Sitges will collect and use rainwater for non-potable activities located close to the collect system. This provides immediate benefits, such as reducing demand for traditional water sources and promoting self-sufficiency.

Using rainfall for green space irrigation can help to conserve water resources, particularly in Sitges where water is scarce. This can be implemented in gardens, for example installing a storage tank either above or below ground, with heavy-duty options for the municipality to use on public green infrastructure.

Using rainwater for irrigation in the park of Les impressionnistes (Asnières) through an underground tank that collects, filter, and store rainwater
(Cost) €€
(Maintenance) Easy to Medium
(Stakeholders) Municipality, water operator
(Co-Benefits) flood protection



Act on domestic consumption

Rainfall in Sitges cannot provide enough water to meet the actual needs of the city in periods of extended water scarcity, pointing to a requirement for water conservation measures to reduce demand.

The use of water-saving equipment can save up to 30 percent of water (EPA, 2017). Behavioral changes will also be required beyond municipal policies by providing best practices and raising awareness.
The EPA has already established guidelines for water-saving measures in commercial buildings, which we suggest as a starting point for Sitges. The implementation of such measures in municipal infrastructure will also reduce the cost of operating these buildings.
(Cost) €
(Maintenance) Easy
(Stakeholders) Private users, Municipality
(Co-Benefits) Financial saving, water resource preservation

STORMWATER HARVESTING TANKS (CAR PARK AND ROADS)

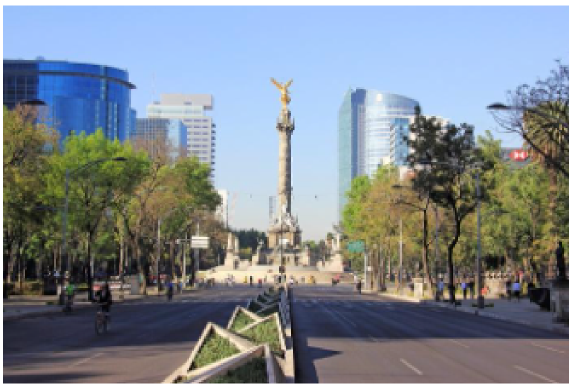
Stormwater harvesting tanks can be located underneath the parking as indicated in the image. The car park will have an inclined pavement to direct water into the harvesting tank, incorporated with SuDS (Sustainable Urban Drainage System)-serving as natural source of water collection. The tank will consist of a pump (used for irrigation, etc.) and solar panels for powering making it independent from the electrical grid. The system will help mitigate the effects of flooding in Sitges during heavy rainfall by retaining and controlling the release of water out of the city.

Cost: €€€
Maintenance: €€€
Stakeholders: Municipality, Private landowners
Co-benefits: Flood protection, water security, helps maintain green infrastructure

BIOCLIMATIC AND SMART CITY
Bioclimatic and smart streets aim to enhance the relationship between the built and natural environments while minimizing the use of non-renewable resources. These use green and gray infrastructure to mitigate the urban heat island effect, reduce stormwater runoff, and improve air quality. Nature-based solutions (NBS) are a form of eco-innovations that specifically promote nature as a solution for climate change, loss of biodiversity, and other issues. Bioclimatic streets can also help address the lack of public green spaces in Sitges.
Bioclimatic streets incorporate several features to promote sustainability, such as greenery, energy-efficient lighting, solar panels, water management systems, smart technology, and mobility solutions. Greenery helps reduce the urban heat island effect, improve air quality, and provide shade, while solar panels generate renewable energy to power streetlights and other infrastructure. Water management systems, such as rain gardens and bioswales, help capture and filter rainwater, while smart technology can monitor and optimize energy use and traffic flow. Mobility solutions involve eco-friendly transportation devices, such as e-bikes and shared devices. Shading can be achieved through high albedo materials or design, while water features provide evaporative cooling.

Rose Kennedy Greenway, Boston

High Line, New York
Rain gardens, green roofs, permeable paving 2009,



Paseo de la Reforma, Mexico City
Bike lanes, pedestrian crossings, green spaces, trees and plants (1942,

5.2 SIMULATIONS

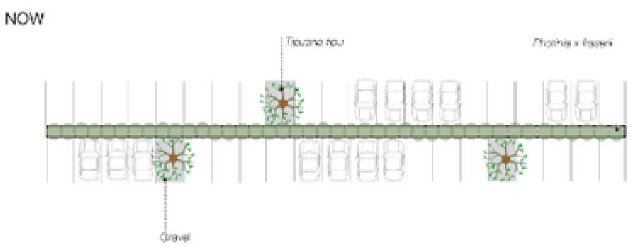
We advise Sitges in their services to integrate the above mentioned elements for the two selected city areas: historic city center and the waterfront.

Historic city center:
A challenge in the city center is obviously that a lot of streets are very narrow and simply don't leave much space to add elements. However, the narrow streets already provide extra shading, which is one of the elements needed. Additionally, we have two solutions for the city center:

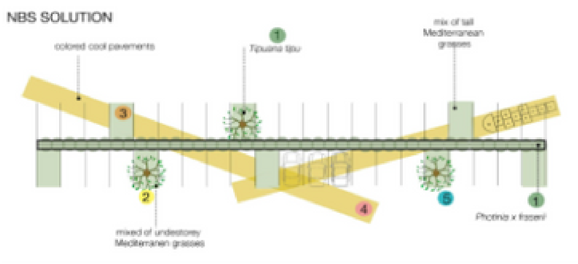
- Parking lots re-design with various bioclimatic elements
- Streets with nature based solutions in the form of green infrastructure
-

Parking lots
Our main aim is to convert parkings into biodiverse green spaces. Parking lots in Sitges are often not shaded and have a high percentage of impervious surface. They are both unwelcoming to their users and they are city heat containers.

Current parking lot, top view:

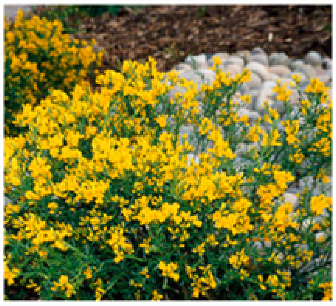


Newly designed parking lot, top view:



Specifically, the proposed solution consists of the following actions:
1 - Preserve existing plant species (Tipuana tipu e Photinia x fraserii) to protect and implement biodiversity
2 - Implement stands with existing trees with ground cover species to increase natural capital.
3 - De-pave a few dedicated parking stalls and replace it with a rain garden. Structure the garden with tall plant species that can provide shade.
4 - Insert strips of colored cool pavements (i.e. hopscotch game) to reduce the heat island and add a fun element.
5 - Propose a rain garden with a bioretention system, for interception of stormwater and capturing pollutants.

Cost: €€
Maintenance: easy
KPI: Increase of shaded and permeable surface area to be measured
Stakeholders: Public
Co-benefits: the increase of natural capital leads to higher validation of visitors to Sitges



(Millstone garden centre, n.d.)
Genista Lydia

Water requirement: Low
Maintenance needs: Low
Sun requirement: High

(Green Acres, 2023)
Laurus nobilis

Water requirement: Moderate
Maintenance needs: Moderate
Sun requirement: Moderate

(The Original Garden Centre, n.d.)
Lagerstroemia Indica

Water requirement: Moderate
Maintenance needs: Moderate
Sun requirement: High

5.2 SIMULATIONS

Streets
The narrow streets in the city center already offer shading, but in the wider streets we propose additions to create a nice and more healthy environment.

Specifically, the proposed solution consists of the following actions:
1 - Add containers with suitable plants
2 - Implement shade with banners/flags (we could propose a re-use of the material used in the harbor) or with a pergola
3 - Implement a green corridor that is evolving according to the season (see picture). For this last solutions we identified species that are matching with the climate of Sitges.

Cost: €€
Maintenance: easy
KPI: temperature measurements comparing similar covered and non-covered streets
Stakeholders: commercial parties in the streets, and event organizers and sponsors
Co-benefits: linking the banners to events enhances the experience of events, and Sitges could use this in promoting good-service to its visitors

(Mafi et al., 2016)

Vinus Vitifera

Water requirement: Moderate
Maintenance needs: Moderate
Sun requirement: Moderate

(The Garden of Eaden, n.d.)

Ipomoea Lobata

Water requirement: Moderate
Maintenance needs: High
Sun requirement: High

(Plants Rescue, n.d.)

Bougainvillea Labra

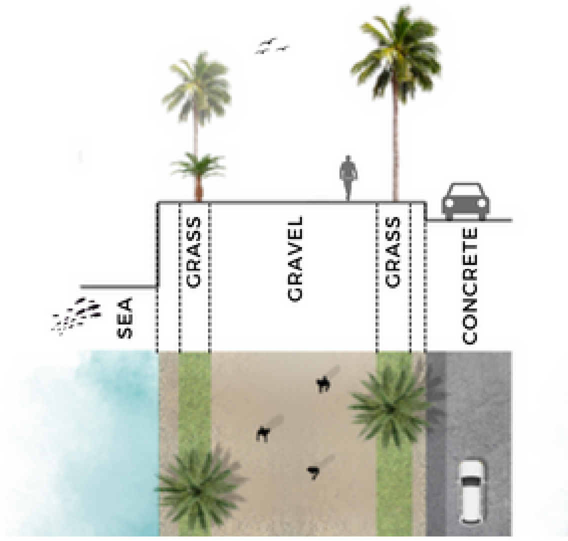
Water requirement: Moderate
Maintenance needs: Moderate
Sun requirement: High

5.2 SIMULATIONS

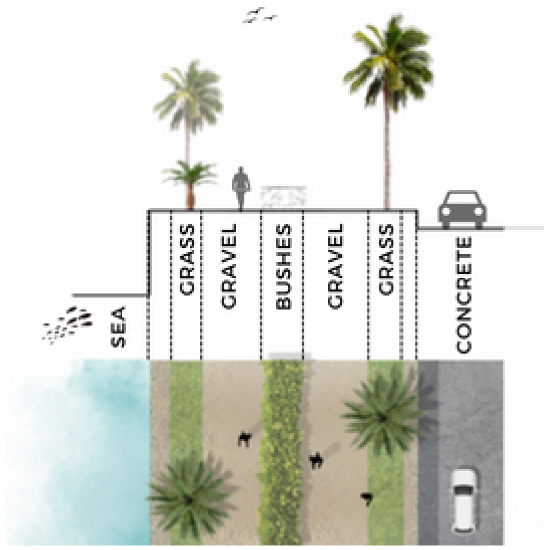
Waterfront

The Sitges waterfront is characterized by the presence of a pedestrian and bicycle path, which are currently not shaded. Moreover, the pedestrian path is flanked along its entire length by a terrace with a grassy surface, which is difficult to maintain due to its proximity to the sea.

EXISTING

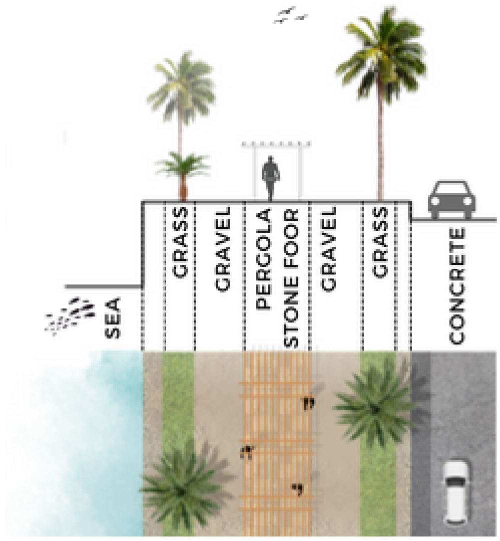


PROJECTED



5.2 SIMULATIONS

PROJECTED



Specifically, the proposed solution consists of the following actions:

1 - Preserve existing plant species (*Washingtonia robusta* e *Tamerix gallica*) to protect and implement biodiversity as well as new plant species fit for this environment that will provide shade, purify the air and attract biodiversity.

2 - Implement shade with a pergola, option 1, or a system of hedge, option 2

3 - Improve the existing lawn with some mediterranean "dry garden" species to implement biodiversity and increase natural capital but also to boost implement social cohesion.

PROPOSED PLANTS ON WATERFRONT

(Waterwise Garden Planner, n.d.)

Quercus Suber

Water requirement: Moderate
Maintenance needs: Low
Sun requirement: Moderate

(Papervale Trees, n.d.)

Cupressus Sempervirens

Water requirement: Moderate
Maintenance needs: Low
Sun requirement: High

(Universidad de Malaga, 2015)

Ficus Carica

Water requirement: High
Maintenance needs: Moderate
Sun requirement: High

TOWARD RESILIENCE

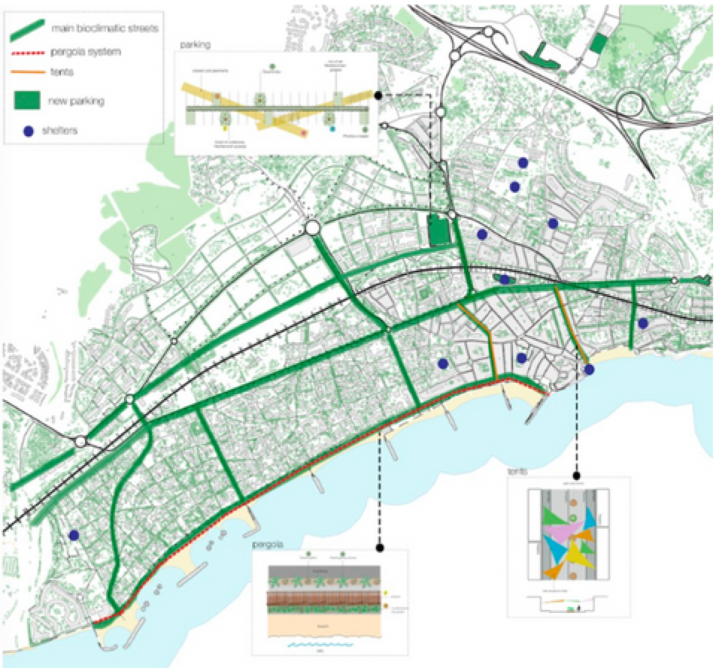
Cost: €€

Maintenance: medium

KPI: Biodiversity Index which measures the variety and abundance of plant and animal species within a city, including both native and non-native species (to be measured by counting e.g. in certain areas)

Stakeholders: commercial parties at the waterfront

Co-benefits: Sitges can maintain its attractiveness of the beach to visitors, even during heat waves



5.2 SIMULATIONS

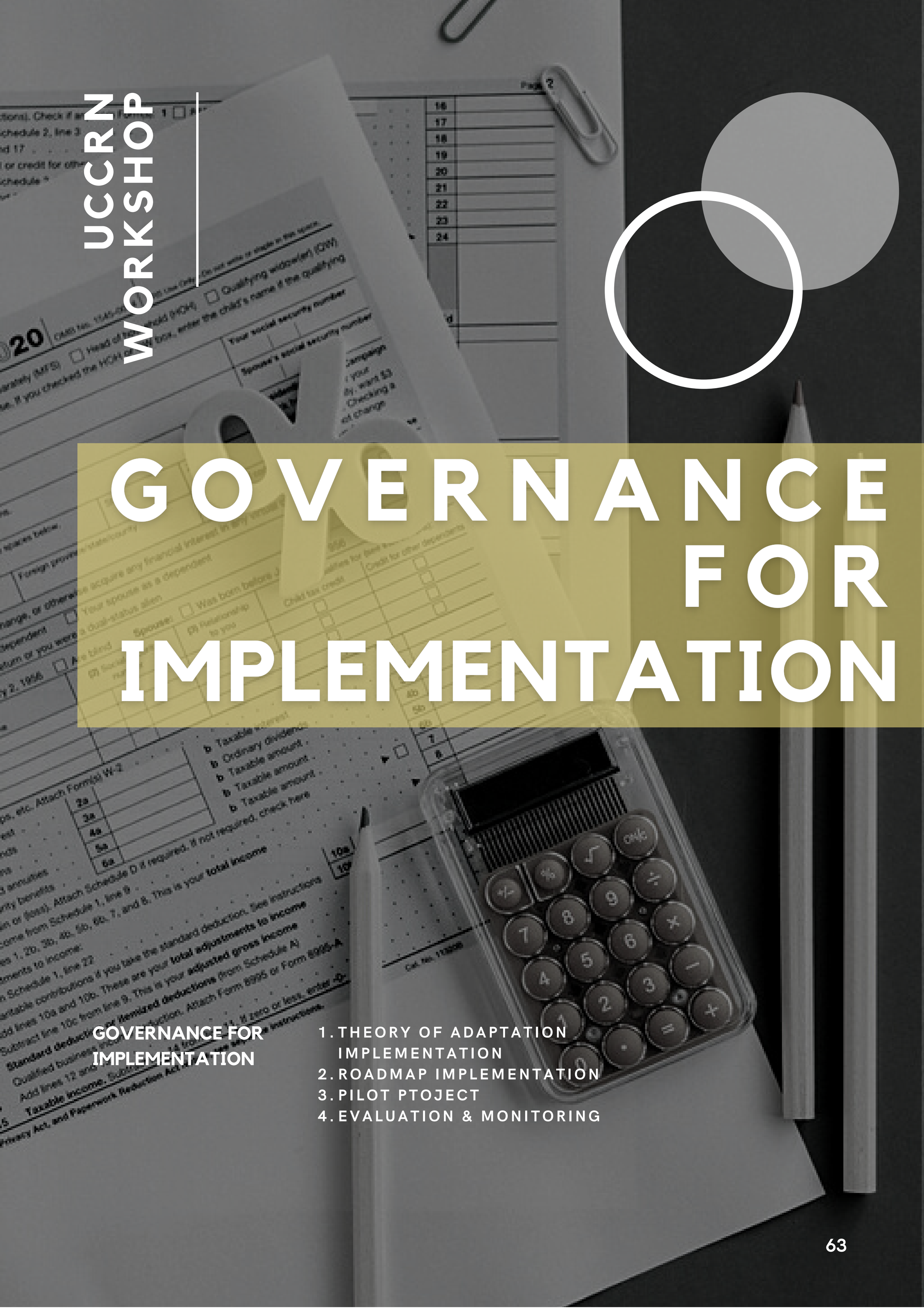
This master plan shows where these solutions can be implemented in Sitges. It is important to consider connections between heat shelters, but also to go beyond by adapting and transforming the city to the microclimate and its evolution in the near future. It is impossible to control the climate, however it is possible to control the city structure. Thus, we have identified streets that can be transformed into bioclimatic ones by first implementing grey solutions within 2-3 years and then by turning them into green solutions that also address water management. We have also identified car parks (Sitges Park Residence) as key points in the mitigation strategy, whereby the solution applied to one of them can be scaled-up to the whole city. Last but not least, the waterfront that is a key point for tourism attractiveness and can also serve the ecosystems, social cohesion and improvement of public health in Sitges.

CONCLUSION

Sitges must go beyond simple heat shelters and implement heat mitigation policies. This section explored a range of different measures. These are short-term rapid solutions, and long-term adaptations aimed at creating greater resilience in Sitges. These policies additionally contain multiple co-benefits but do have trade offs, highlighting the need for a holistic plan and vision.

This project is a small window into the science of climatology, urban climate sciences and sustainable development based on available data and the current sciences of these subjects. Limitations were also encountered regarding time limits and technical feasibility.

The implementation of these policies will require greater analysis of the structure of governance of Sitges, stakeholder and funding. Moreover, for these policies to be efficient, they must be monitored. This will allow the measurement of implementation and management and the effectiveness of each policy. For this reason, the next chapter will introduce suggested Key Performance Indices (KPIs).



UCCRN WORKSHOP

GOVERNANCE FOR IMPLEMENTATION

GOVERNANCE FOR IMPLEMENTATION

1. THEORY OF ADAPTATION IMPLEMENTATION
2. ROADMAP IMPLEMENTATION
3. PILOT PTOJECT
4. EVALUATION & MONITORING

6.1 THEORY OF ADAPTATION IMPLEMENTATION

Adapting to the impacts of climate change is critical for ensuring the resilience of societies and ecosystems. Here, adaptation strategies are defined as a general plan of action for addressing the impacts of climate change, including climate variability and extremes, such as heat waves. Effective adaptation planning and implementation require a comprehensive, multi-sectoral, and participatory approach that takes into account the objectives and needs of different stakeholders, with the overarching objective of reducing vulnerability to climate change impacts (Duc, 2014). The work suggests supporting the concept of robust evidence and high agreement.

To ensure successful adaptation implementation, it is important to conduct a thorough assessment of the risks and vulnerabilities that the system faces. This should be done using robust data, models, and scenario analysis to develop adaptation measures that are flexible and adaptive over time (Duc, 2014). Future monitoring and evaluation of the measures implemented will be necessary to assess their effectiveness and identify areas for improvement.

Cooperation and coordination among stakeholders at different levels, including government agencies, the private sector, and civil society is also required for effective adaptation. Coordination across sectors and scales is also essential to ensure coherence and avoid unintended consequences (Duc, 2014). To support successful adaptation, implementation should be inclusive and participatory, involving all relevant stakeholders in the decision-making process (Duc, 2014). Adequate resources, including financial and technical support, must also be made available to support effective adaptation planning and implementation. This includes investing in capacity building, research and development, and the deployment of appropriate technologies and practices.

6.1 THEORY OF ADAPTATION

Overall, effective adaptation implementation requires a comprehensive and participatory approach that is flexible, adaptive, and coordinated across sectors and scales (Duc, 2014). This approach should be underpinned by robust data and scenario analysis, with continuous monitoring and evaluation to ensure that the measures implemented are effective and meet the needs of all stakeholders.

We have extracted seven criteria for effective adaptation implementation that should be fulfilled to maximize the chances of project success:

- Adaptation planning should be integrated with existing planning processes and take into account other policy goals and objectives.
- Adaptation measures should be based on a thorough assessment of the risks and vulnerabilities that the system faces.
- Adaptation measures should be designed to be flexible and adaptive, to account for uncertainties and changing conditions.
- Implementation of adaptation measures should be accompanied by appropriate monitoring and evaluation, to assess effectiveness and identify areas for improvement.
- Adaptation planning and implementation should involve a participatory and inclusive process, to ensure that stakeholders are engaged and their concerns and needs are taken into account.

- Adequate resources, including financial and technical support, should be made available for effective adaptation planning and implementation.
- Adaptation planning and implementation should be coordinated across sectors and scales, to ensure coherence and avoid unintended consequences.

6.2 SITGES CAPACITIES AND RISK

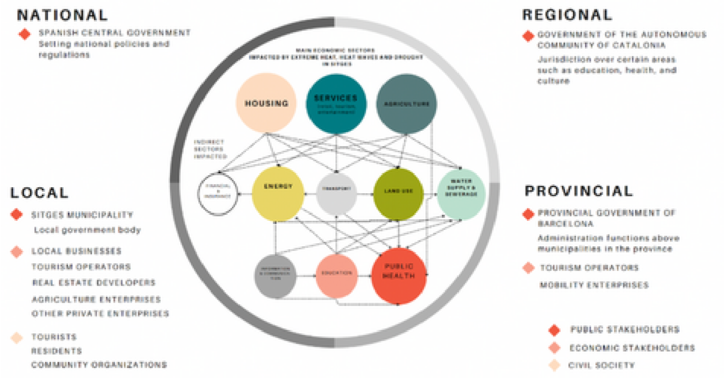
The implementation of heat adaptation measures in Sitges involves various stakeholders, including governmental and economic stakeholders. The Spanish central government, the Autonomous Community of Catalonia, the Provincial Government of Barcelona, and the Sitges Town Council are important government stakeholders that need to be involved in the development of effective heat adaptation plans.

Community organizations, such as neighborhood associations and environmental groups, can also play a crucial role in raising awareness and advocating for the needs of vulnerable populations. Involving the general population and people working in Sitges is equally important.

Economic stakeholders, such as local businesses, real estate developers, and tourism operators, have a direct impact on the town's economic growth and development and can contribute to heat adaptation by investing in energy-efficient infrastructure, promoting sustainable tourism practices, and incorporating climate-resilient design features into new developments.

Overall, the involvement and cooperation of all stakeholders are necessary to ensure the effective implementation of heat adaptation measures that protect the health and well-being of residents and visitors in Sitges.

By taking action to mitigate the impact of extreme heat and promoting sustainable development, the town can work towards a safer and more resilient future.



The visual seen here illustrates the potential costs of inaction in Sitges, regarding extreme heat waves. Failure to address issues could result in increased healthcare costs, infrastructure damage, reduced economic activity, decreased public trust in the government, and electors' disappointment. The various stakeholders involved, including governmental actors, civil society stakeholders, and economic stakeholders, have concerns about protecting residents and tourists, maintaining economic activity, and addressing the impacts on vulnerable populations. The agricultural sector also faces pressure from urban expansion and the need for water supply during drought periods. Overall, the interconnections and dependencies illustrate the importance of taking action to address the impacts of extreme heat waves in Sitges to prevent negative consequences for the town and its stakeholders.

COMMUNICATION PLAN

To gain support with local stakeholders, a two path communications campaign is suggested. One Campaign will focus on Public Health, aiming for building knowledge on the dangers of heat, gaining support for adaptation building by local stakeholders and informing on the location of heat shelters. The second Campaign should focus on City Branding by entailing Economic Stakeholder Activation and City Marketing. Full details of the Communication Plan are included in the Appendix to this report.

PUBLIC HEALTH CAMPAIGN

Domains of Communication	Key Message	Catalyst	Channel	Target Audience	Objective
Education on Heat Dangers	In case of extreme heat please be prepared and aware of the risks	Expert	Workshop/Training	Government officials	Generate Know-How
		Government	Working Groups for communication, Trainings, Events	Emergency responders, public health officials, urban planners, public school teachers, business owner, tourism industry representatives, agricultural enterprises, real estate developers	Instill deeper knowledge and responsibility for civil society with purpose of passing on the message
Heat Shelter Promotion	Heat shelters are available here and this is how you use them		Maps, Social Media, Posters, Letters, Events, Schools, Healthcare Providers, Public Service Announcements, Hotels	Civil Society, Vulnerable population, Tourists, Workers	Instilling knowledge

CITY BRANDING

Domains of Communication	Key Message	Catalyst	Channel	Target Audience	Objective
Economic Stakeholder Activation	Sitges wants to be best-in-class in tourism and quality of life now and in a sustainable future and wants to invest	Government (specifically Garraf Region)	Economic stakeholder events, Advertising, lobby Groups	Business owners, tourism industry representative, agricultural enterprises, real estate developers, Event organizers	Gaining funding for extensive climate adaptation projects
City Marketing	Sitges is providing the best services to its visitors, even in heat	Government	Social Media, Advertising, Events	Global Audience, Tourists	Image building as a sustainable city to gain wider EU funding and increase economic activity

This implementation plan has been developed to incorporate the responses developed and findings extracted in Chapter 4 (Shelters), Chapter 5 (Beyond Shelters), Chapter 1 (Community consultation) and 9.d. (Communication). A streamlined strategy for delivery of climate adaptation and mitigation measures is difficult to conceptualize at this stage of planning as solutions need to be tailored to very specific needs that would require further inspection. Nevertheless, we would advise a row of consecutive measures that begin with a duality of civil society stakeholder involvement, education and heat wave preparedness.

6.1 THEORY OF ADAPTATION

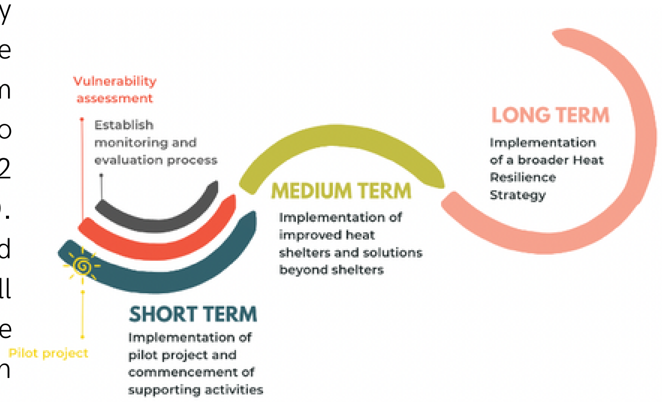
To ensure that the potential heat resilience plans are implemented effectively it is important to indicate who is responsible for implementation and a timeline of implementation. We also recommend that ongoing monitoring, evaluation, and adjustment is undertaken through the indicators outlined in Chapter 7 (Monitoring and Evaluation). Together these chapters outline a clear roadmap for Sitges to move forward and implement a holistic heat resilience strategy.

6.2 ROADMAP IMPLEMENTATION

6.2 ROADMAP IMPLEMENTATION

A comprehensive approach to developing a holistic heat strategy is proposed to be implemented over the short, medium and long term.

Short term:
In the short-term it is recommended that Sitges proceed with a pilot project which focuses on implementation of a pilot heat shelter project located at Edifici Miramar as well as a supporting communications pilot project. In parallel to this, it is considered necessary to conduct a heat vulnerability assessment to identify the most vulnerable community members and understand whom the resilience projects are intended to support, as outlined in Chapter 2 (vulnerability assessment roadmap). Establishment of a monitoring and evaluation process in the short term will provide the basis for understanding the impacts and success of the adaptation measures, and will help the city to scale up the initiatives, secure funding and to ensure the initiatives are providing effective solutions moving forward.



Medium term:
The medium term strategy should focus on evaluation and refining solutions implemented during the short-term. Additionally there is an opportunity to commence development of solutions beyond shelters, as outlined in Chapter 5 (Beyond Shelters). It is imperative to continue the established monitoring and evaluation process, as outlined in Chapter 7 (Monitoring and Evaluation).

Long term:
The long term strategy should focus on implementing a broader Heat Resilience Strategy that supports implementation of actions with multiple co-benefits to address the multiple challenges presented by climate change.

Prioritization
The implementation plan includes possible priorities which are subject to future consideration by Sitges and could be improved through ongoing monitoring activities and ongoing engagement with the community and key stakeholders. As each solution may perform differently it is important to undertake a structured Multi-Criteria Analysis (MCA) to determine preferences amongst alternative options. Within this report a simple MCA framework has been developed to prioritize the potential responses based on the below criteria, however there are many tools that Sitges could utilize to undertake a detailed MCA assessment.

POTENTIAL TOOL

Potential tool for Sitges: CLImate ACTions Prioritization (CLIMACT Prio)
CLIMACT Prio is a climate awareness, decision support and capacity building tool for screening and prioritizing of local climate change actions. CLIMACT Prio utilizes a multi-criteria approach to assist decision makers and urban planners to identify a wide range of decision criteria and set priorities among objectives while performing an analysis and assessment of climate change (mitigation or adaptation) actions. This tool was developed by Institute for Housing and Urban Development Studies (IHS) (Erasmus University Rotterdam) and more information is available here: https://www.ihs.nl/en/advisory-training-and-research/tools-and-toolkits

The simple MCA analysis used the above methodology to qualitatively assess the benefits of implementing these strategies develop a concise overview of the potential prioritization for implementation. The results of the MCA are provided within the Appendix to this report. This prioritization ranking provides guidance to Sitges for how to potentially implement the strategies and has informed the selection of a Pilot project. For example, coding of the responses indicates the highest priority actions to be implemented are:

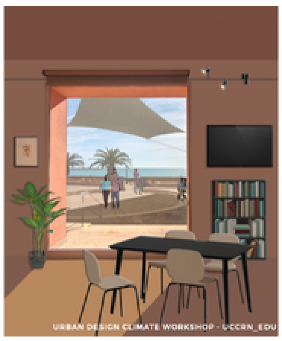
- Street shading
- Green corridors
- Cool roofs
- Act on domestic consumption
- Conversion of parking into biodiverse greenspace
- Shade and green the waterfront

6.3 PILOT PROJECT

Lighting the Way: A Pilot Heat Shelter Project

The objective of the project is to create a light house heat shelter in a short period of time that can serve as a testing ground for the upcoming heatwave and a scalable solution for other locations, as well as to secure wider funding. The facility will be open 365 days a year from 8 am to 8 pm, with possible expansion to 24/7 depending on the demand. The building will host courses, activities, and community events in the garden. Additionally, there will be trained healthcare staff onsite, responsible for data collection, and a potential pick-up service for vulnerable groups with reduced mobility. The space is considered safe, highly adaptive to seasonal needs, and utilized frequently.

The selected location for the pilot project is Edifici Miramar C. de Fonollar, 19, 08870 Sitges, chosen for its accessibility and existing facilities. The building amenities include comfortable tables and chairs, entertainment, trained healthcare staff, a water station, mini-kitchen, solar panels, A/C units for a short-term solution, Wi-Fi, and electricity outlets. Outdoor amenities include seating capacity, artificial canopies, cool roof with reflective paint, Mediterranean plants, depaving, water nebulizer, and a ramp for accessibility. The pilot project will serve as a testing ground and a way to gain political support for further heat shelter projects and investments. The necessary adjustments will be within a budget of approximately €6000.



6.3 PILOT PROJECT

Shelter from the Sun: A Pilot Pergola Project

The objective of the Shelter from the Sun pilot project is to create an adaptable and extendable pergola along the beach walk. The project will be funded through private economic stakeholder funding, which will contribute to community cohesion, shelter, event space, and endemic plant regeneration.

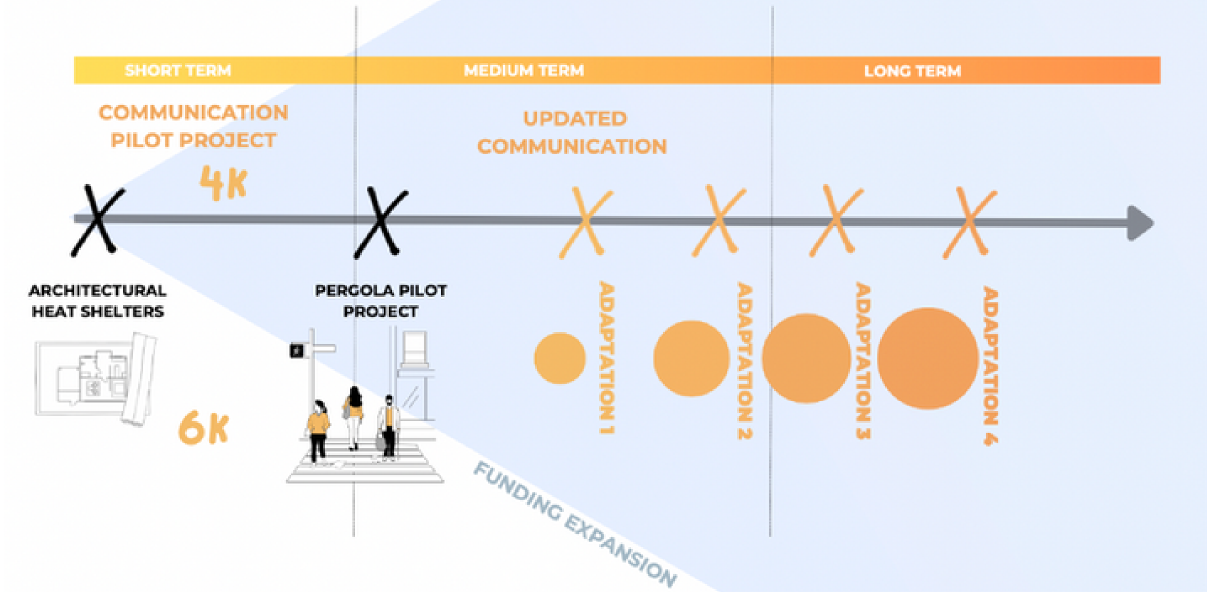
The facility management and funding of the project will be carried out by private economic stakeholders who can invest in the project and receive equity in terms of space usage for events or mobile stores. Public Private Partnerships can also secure further funds for the project through the City Branding Campaign. Returns on investment can be generated through rental and licensing of the space. Data on usage will be collected through sensor analytics to understand how the space is being utilized.

The space can be used for community events and markets, and expansion can be done progressively based on community feedback. The Shelter from the Sun pilot project will have co-benefits such as the creation of shaded public space and revenue generation. The project will also revitalize local flora and can be used as part of the City Branding Campaign.

6.3 PILOT PROJECT

Overall, the Shelter from the Sun pilot project aims to create a sustainable and community-oriented space that provides shelter from the sun while promoting local flora regeneration and community events. Through private economic stakeholder funding, public-private partnerships, and data-driven management, the project will create a model that can be replicated and expanded in other locations.

PILOT PROJECT IMPLEMENTATION TIMELINE



6.4 MONITORING & EVALUATION

M&E Methodology

A mixed-method Monitoring and Evaluation (M&E) methodology is a cyclical process that combines both quantitative and qualitative data collection and analysis methods to provide a comprehensive understanding of a project or program's effectiveness, efficiency, and impact. Determining the most appropriate data collection method will be dependent on the indicator being measured, as outlined below. Disparities between quantitative and qualitative data should be extensively analysed as these inconsistencies provide crucial insights into the disparities between planning and lived reality.

A M&E methodology should include hard data collected through statistics, but also interview and survey responses to provide a holistic understanding of the project's progress towards its goals. Qualitative data should be collected by governmental stakeholders and potentially community organizations to obtain a variety of perspectives and experiences. Expert interviews can also provide low-cost and extensive input.

The M&E methodology should also be a cycle that involves ongoing monitoring, evaluation, and adjustments to ensure continuous improvement.

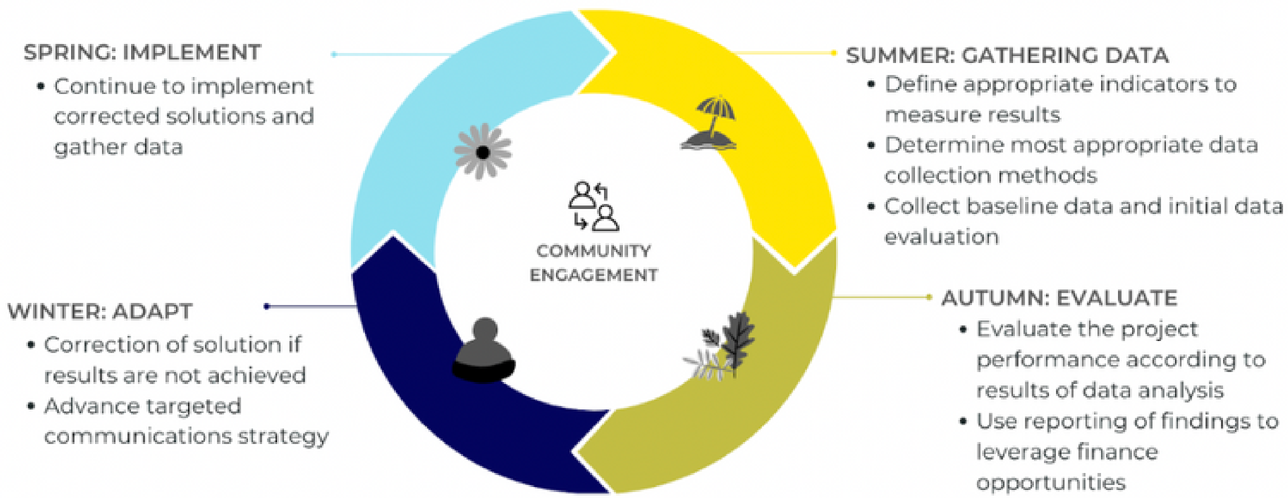
6.4 MONITORING & EVALUATION

Overall, a good mixed-method M&E methodology should be designed to provide a comprehensive understanding of a project's effectiveness, incorporate both quantitative and qualitative elements, and involve ongoing monitoring and evaluation to ensure continuous improvement.

M&E cycle

The M&E cycle proposed below has been designed to provide a robust framework for Sitges to establish and continue monitoring and evaluation of the proposed solutions.

Monitoring the impacts and success of the adaptation measures will help the city to scale up the initiatives, secure funding and to ensure the initiatives are providing effective solutions (C40 Cities, 2019). The objectives of each phase of the cycle are explained further below.



Community Engagement

Throughout each stage of the process it is important to continue engagement with the community to ensure that the solutions being promoted are appropriate to the needs of the community. This engagement provides an opportunity to communicate on what has been achieved and demonstrate the benefits of the solutions. For further information on Community Engagement refer to Chapter 1.

Summer: Gathering Data

The initial phase of the monitoring and evaluation cycle is focused on building an evidence base to identify successful adaptation solutions. It is important to note that qualitative and quantitative data should be collected in the summer time as changed perceptions in other seasons can alter results. The data collection should be undertaken in line with the pre-defined indicators. It is important that a baseline of the situation is understood prior to the implementation of the adaptation actions in order to track trends and progress. Either qualitative or quantitative data can be collected and it is possible that existing data (such as official government statistics) may also provide data.

Autumn: Evaluate

Evaluation is a crucial phase of the cycle to reflect on the data that has been gathered and collect lessons learned. Reporting on the results will provide an opportunity to communicate what has been achieved in a transparent way and can potentially unlock financing for further adaptation measures.

Winter: Adapt

Once the benefits, or challenges, of the solutions are understood, the adapt phase provides the opportunity to correct the solutions or improve on them further. Adaptation of the solutions should only be undertaken when sufficient data has been collected and clear trends are emerging which allow stakeholders to identify appropriate measures to change.

6.4 MONITORING & EVALUATION

Spring: Implement

In coordination with key stakeholders, the municipality of Sitges will continue to identify opportunities with public and private implementation partners to continue to implement corrected solutions and gather data.

Key Performance Indicators

In conjunction with M&E, it is important to define and begin tracking Key Performance Indicators (KPIs) to measure the impacts of solutions. As outlined in the M&E cycle above, ongoing measurement allows performance of the solutions to be tracked and modified if the policies and interventions are not progressing goals or impacts.

KPI

C40 Cities (2019) recommend the quality of indicators should be assessment through a structured rating which recommends that indicators should be:

> Clear: precise and unambiguous

> Relevant: appropriate to the subject at hand

> Economic: available at a reasonable cost

> Accepted: accepted as relevant measure by stakeholders

> Monitorable: amenable to independent validation.

6.4 MONITORING & EVALUATION

Pilot Project:
These KPIs have been designed to align specifically with the pilot project outlined in Chapter 6. These KPIs have been developed to suit the context of Sitges and recommend a blend of qualitative and quantitative approaches to measure both the outcome and impact of the projects.

Action	Key Performance Indicator (KPI)	Method of data collection	When will the indicator be measured?
Lighting the way: A pilot heat shelter project			
Outcome: accessibility of heat shelters	Number of heat shelter visitors and duration of stay / per population within 15 minutes walking distance of the heat shelter	Manually recording the number of shelter visitors during the summer season and survey of duration of stay. GIS analysis to determine the population living within 15 minutes walking distance of the heat shelter.	Initial baseline assessment followed up yearly, prior to likely heatwave events.
Impact: Reduced vulnerability to extreme heat/heatwaves	User satisfaction level that the heat shelter is equipped to deliver needed services.	Survey of heat shelter users to assess the perceived performance of the heat shelter.	Survey undertaken during heatwave events when the heat shelter is actively utilised, followed up yearly.
Shelter from the sun: A pilot pergola project			
Outcome: Improved temperatures from additional share during extreme heat/heatwaves	Temperature difference (°C) between shaded spaces and non-shaded spaces	Quantitative analysis using an instrument such as a digital thermometer	Monitoring of temperatures at regular intervals during periods of high heat
Impact: Reduced exposure to extreme heat/heatwaves	High user satisfaction level	Survey of perceived performance of the pergola in reducing exposure to extreme heat/heatwaves	Survey undertaken during heatwave events when the pergola is actively utilised, followed up yearly.

6.4 MONITORING & EVALUATION

This report has presented many solutions and ideas for Sitges to proceed with in future as part of a broader heat resilience strategy. Below are a range of proposed KPIs for Sitges to consider monitoring in future. These indicators can be adjusted as required to the future solutions that are implemented.

Action	Key Performance Indicator (KPI)	Method of data collection	When will the indicator be measured?
due to exposure to heat and negative health outcomes.	hospitals during summer with heat related illnesses. Number of deaths occuring in Sitges and nearby hospitals during summer months.	centres and hospitals.	compared with a baseline of average values from previous years.
Energy and waste heat: reduced energy usage to minimize waste heat and greenhouse gas production.	Energy consumption per capita.	Quantitative data collection from energy providers.	Calculated on a monthly basis at minimum, considering seasonal variation in population. To be collected for annual comparisons.
Water management: Reduced speed and quantity of storm-water runoff within Sitges.	Runoff flow rate. Volume of water captured and storage capacity.	Ongoing monitoring or flow rates and water storage levels.	After project implementation and after major alterations to the urban surface. Runoff flow rates need constant monitoring.
Urban design: Bioclimatic streets in the core of Sitges created using green infrastructure to target the streets most affected by the heat island effect.	Universal Thermal Comfort Index.	Composite index of quantitative data.	Ongoing data collection to be compared with a baseline of average values from previous years.
	Area (m²) of canopy cover and shade cover created.	Quantitative data analysis, potentially using a tool such as iTree or GIS.	
	Biodiversity Index which measures the variety and abundance of plant and animal species within a city, including both native and non-native	Quantitative data analysis.	

UCCRN WORKSHOP

APPENDIX

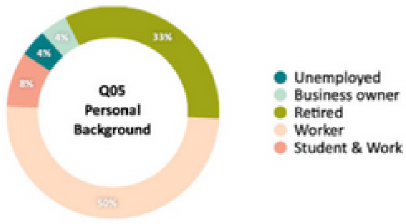
APPENDIX

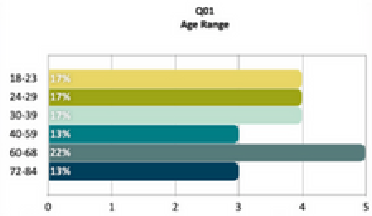
SURVEY
MCA RESULTS
COMMUNICATION PLAN

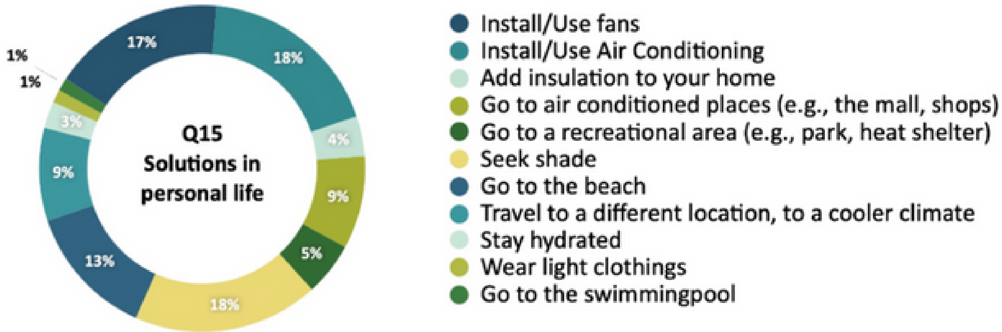
SURVEY

Participants in General

- 33% male & 67% females **mostly from Spain** but with some tourist
- With regard to **vulnerable groups with disability or medical conditions**, pregnant women, **elderly**, low income communities, children, outdoor workers and people with pets.

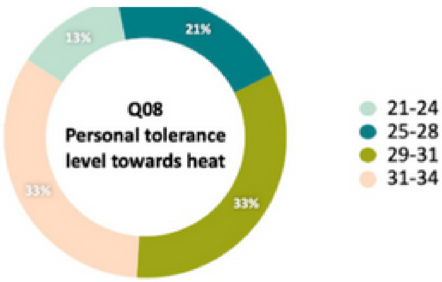


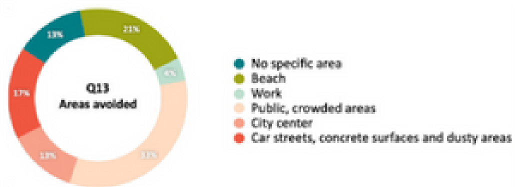


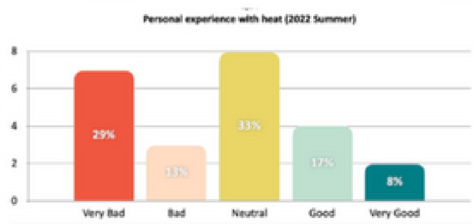


Perception of Heat I.

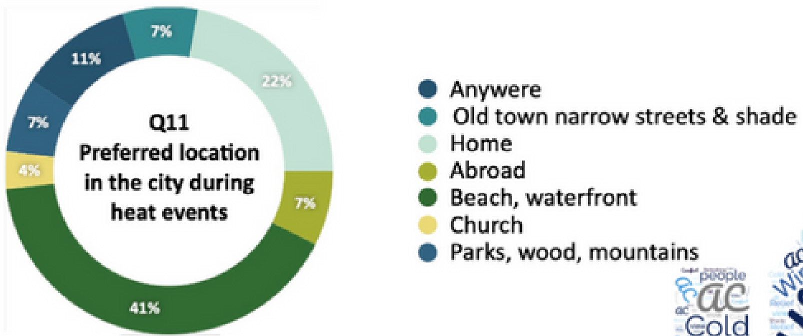
- Most participants agreed that there is **discomfort and negative experience from heat events.**
- From areas **to avoid** in heat, most participants brought attention to **public & crowded areas** at 33%, **beach** at 21% and **streets & concrete surface** at 17%.







Perception of Heat II.



SURVEY

What would you change in the city to make it more comfortable during hot temperatures?

Participant 1: Do something for old people, climate shelter such as the library. Create tents on top of narrow streets to create shade.
Participant 2: More shade and benches to sit on and catch my breath
Participant 3: More public pools, and more public heat shelters
Participant 4: Heat shelter including the homeless people. Handing out water and mist devices.
Participant 5: Dry climate use water evaporation fans and in humid weather ice cold towels.
Participant 6: Have more water surfaces
Participant 7: More shade for kids play areas, heat shelters, drinking water available for children and dogs
Participant 8: Have water dispensers, more shade and water
Participant 9: Park with trees
Participant 10: Public showers
Participant 11: Water fans
Participant 12: Water vendors
Participant 13: Go home and take rest

KEY TAKEAWAYS

- City as a network, where connections and stops are provided, including bigger and smaller elements (heat shelters, cold passagers, drinking water stations etc...)Think about awareness, wayfinding and education

- Provide more open and public spaces with shade, water dispenser devices and benches (sustainable heat shelters)

- Create water surfaces and pools accessible to the public.

- Socially and environmentally just designs (with high regard to elderly, homeless people, children and dog owners).

APPENDIX

MCA RESULTS

Actions	Responsibility	Prioritization matrix			Coded score
		Co-benefits	Financial viability	Effectivenes s	
Grey Infrastructure					
Cool roofs	Municipality, Building owners	Medium	High	Low	6
Façades	Municipality, Building owners	Medium	Low	Low	4
Green corridors	Municipality	High	Medium	High	8
Street shading	Municipality, Building owners	High	High	High	9
Water management					
Rainwater management: Surface runoff	Municipality	Medium	Low	Low	4
Rainwater management: Rainwater harvesting	Municipality	Medium	Medium	Low	5
Act on domestic consumption	Private users, Municipality	Medium	High	Low	6
Stormwater harvesting tank (car parking and roads)	Municipality, Private land owners	Medium	Medium	Low	5
Bioclimatic and smart city					
Conversion of parking into biodiverse green space	Municipality, Land owners	Medium	Low	High	6
Shade and green the waterfront	Municipality	High	Low	Medium	6
Improve streets within the historic centre	Municipality	High	Low	Low	5

COMMUNICATION PLAN

To gain support with local stakeholders, a two path communications campaign is suggested. One Campaign will focus on Public Health, aiming for building knowledge on the dangers of heat, gaining support for adaptation building by local stakeholders and informing on the location of heat shelters. The second Campaign should focus on City Branding by entailing Economic Stakeholder Activation and City Marketing.

1. Public Health Campaign

The public health campaign aims to educate the community on the dangers of extreme heat and promote the availability and use of heat shelters. The campaign will involve experts and the government as catalysts to communicate key messages to the target audience through various channels.

To generate know-how, workshops and training sessions will be conducted for emergency responders, public health officials, urban planners, public school teachers, business owners, tourism industry representatives, agricultural enterprises, and real estate developers. The training will equip them with the knowledge and skills needed to recognize the risks of extreme heat and how to respond appropriately.

Working groups will also be formed to facilitate communication, organize trainings, and plan events that will raise awareness among the general public. Maps, social media, posters, letters, events, schools, healthcare providers, public service announcements, and hotels will be used as channels to reach the target audience. The key message to be communicated is that in case of extreme heat, individuals need to be prepared and aware of the risks, and heat shelters are available for their use. The campaign will instill deeper knowledge and responsibility for civil society with the purpose of passing on the message and promoting heat shelters. The target audience includes civil society, vulnerable populations, tourists, and workers. By educating and promoting the use of heat shelters, the campaign aims to reduce the number of heat-related illnesses and deaths, and ultimately create a safer and healthier community while generating support for adaptation measures in civil society.

2. City Branding Campaign

The city of Sitges could become a best-in-class destination for tourism and quality of life, both now and in a sustainable future through implementing a city branding campaign. To achieve this, the city could invest in extensive climate adaptation projects to provide the best services to its visitors, even in the heat.

The government, specifically the Garraf Region, could act as a catalyst for a city branding campaign. To activate economic stakeholders, events could be organized to showcase the benefits of investing in Sitges. Business owners, tourism industry representatives, agricultural enterprises, real estate developers, and event organizers could be targeted. Advertising and lobby groups could be used as channels to reach them.

The key message to be communicated could be that Sitges is a city that is committed to sustainable tourism and is investing in climate adaptation projects to ensure the best possible experience for visitors. This message could be communicated through social media, advertising, and events. The objectives of the campaign could be twofold. Firstly, to gain funding for extensive climate adaptation projects that could ensure Sitges remains a top tourist destination, even in the face of climate change. Secondly, to build an image of Sitges as a sustainable city that could attract wider EU funding and increase economic activity.

The target audience for this city branding campaign could be global, with a particular focus on tourists. By building an image of Sitges as a sustainable and climate-resilient city, the campaign could attract more tourists and generate more economic activity.

Communication Channels

Developing effective heat wave adaptation strategies requires a multi-stakeholder approach that involves government officials, civil society organizations, and economic actors. To ensure that everyone is adequately prepared for the impacts of extreme heat, it is important to engage these different stakeholders through a range of communication channels and educational tools. This can include workshops and training sessions for government officials, social media campaigns and community events for civil society organizations, and incentives and awards for economic actors who invest in heat resilience measures. By bringing together diverse perspectives and expertise, we can work towards a more resilient and sustainable future, even in the face of climate change. Following is a range of appropriate communication channels:

- Governmental Stakeholders
  - Workshops and training sessions: Organize workshops and training sessions for local officials, emergency responders, public health officials, and urban planners to learn about the impacts of heat waves and effective adaptation strategies.
  - Interagency working groups: Establish interagency working groups to facilitate communication and collaboration among different governmental stakeholders. These groups can meet regularly to discuss heat wave adaptation strategies and share information and resources.
  - Webinars and online resources: Develop webinars and online resources, such as e-learning modules, toolkits, and guidance documents, to educate different governmental stakeholders about heat wave adaptation.
  - Joint exercises and simulations: Conduct joint exercises and simulations among different governmental stakeholders to test their readiness to respond to heat wave emergencies.
  - Collaborative planning and decision-making: Involve different governmental stakeholders in collaborative planning and decision-making processes related to heat wave adaptation. This can help ensure that adaptation strategies are informed by the best available science and are aligned with the needs and priorities of different stakeholders.
  - Information-sharing platforms: Establish information-sharing platforms, such as online forums or social media groups, to facilitate communication and knowledge exchange among different governmental stakeholders.
  - Education programs at Schools: Schools are a reliable channel through with to communicate knowledge on heat resilience and relay information to family members of the children.

- Civil Society
  - Social media: Social media platforms like Facebook, Twitter, Instagram, and LinkedIn can be used to raise awareness about the need for heat shelters during heat waves.
  - Civil society organisations can use these platforms to share information about the location of heat shelters, the benefits of using them, and tips for staying cool during a heat wave.
  - Community events: Community events, such as street fairs, block parties, and farmers markets, can be used to educate people about the importance of heat shelters. Civil society organizations can set up booths at these events to distribute information, answer questions, and provide resources to those who need them.

- Local media: Local newspapers, radio stations, and TV stations can be used to spread the word about heat shelters. Civil society organizations can reach out to local media outlets to share information about heat shelters and their benefits.
- Outreach to community-based organizations: Civil society organizations can partner with community-based organizations, such as senior centers, youth organizations, and health clinics, to promote heat shelters. These organizations often have direct contact with the populations that are most vulnerable to heat waves and can help to distribute information about heat shelters.
- Environmental and social justice advocacy groups: Environmental and social justice advocacy groups can be powerful allies in promoting heat shelters. These groups can help to raise awareness about the importance of heat shelters and can advocate for policies that support their development and implementation.
- Town Maps and markers: Maps and markers that are updated to provide information on basic services such as heat shelters, water stations, shaded areas and public toilets.
- Public Service Announcements: PSAs can be used to raise awareness about the dangers of heat waves and promote responsible behavior. These could be broadcasted on TV, radio, or even online

- Economic Sector
  - Personalized emails or letters: Sending personalized emails or letters to business owners, tourism industry representatives, and real estate developers can be an effective way to make them feel personally responsible for their workers' safety during heat waves. These emails could include information about the risks of heat waves and the potential impact on their workers, as well as tips and resources for heat resilience.
  - Social media campaigns: Creating a social media campaign around heat resilience and worker safety can be a powerful way to engage with economic actors and inspire them to take action. For example, a campaign could encourage businesses to share photos of their heat-resilient workplaces and highlight the steps they have taken to protect their workers.
  - Webinars or workshops: Hosting webinars or workshops specifically targeted at economic actors can be an effective way to educate them about the risks of heat waves and the importance of investing in heat resilience measures. These sessions could be led by experts and include case studies of businesses that have successfully implemented heat resilience strategies.
  - Industry associations and trade organizations: Leveraging industry associations and trade organizations can be an effective way to reach a wide range of economic actors and inspire them to invest in heat resilience measures. These organizations can offer guidance and resources, as well as opportunities for businesses to share best practices and learn from one another.
  - Incentives and awards: Offering incentives or awards for businesses that invest in heat resilience measures can be a powerful motivator. For example, an industry association could offer a heat resilience certification or an award for the most innovative heat resilience strategy. This can encourage businesses to prioritize heat resilience and recognize those that are leading the way.
  - Charity Events: Charity events can help to raise awareness about the risks of heat waves and the importance of protecting workers, while also providing an opportunity for businesses to give back to their communities

UCCRN WORKSHOP

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