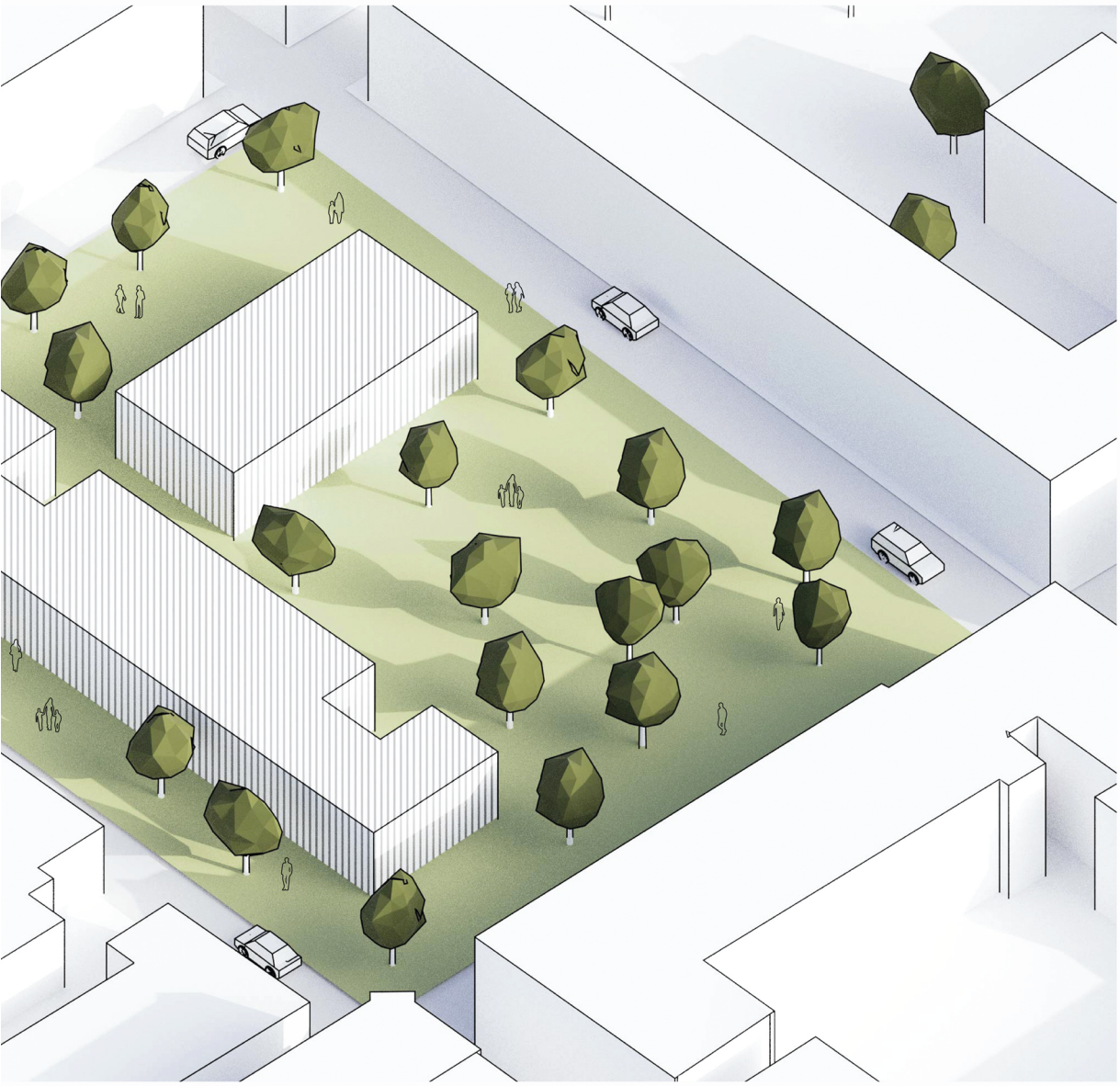


Urban Climate Shelter to adapt cities to climate change

A strategy for re-designing schoolyards in Turin (Italy)

Politecnico di Torino

POLITECNICO DI TORINO

Master's degree programme in
Territorial, Urban, Environmental and Landscape Planning
Curriculum: Urban and Regional Planning
Academic Year 2022/2023

URBAN CLIMATE SHELTER TO ADAPT CITIES TO CLIMATE CHANGE.
A strategy for re-designing schoolyards in Turin (Italy)

Supervisor
Prof. Ombretta Caldarice

Co-Supervisor
Prof. Nicola Tollin

Candidate
Bruna Pincegher

December 2023

This thesis was developed in the frame of the internship at the Southern University of Denmark (SDU), under the supervision of Nicola Tollin, in collaboration with the Responsible Risk Resilience Centre (R3C) of the Politecnico di Torino, under the supervision of Ombretta Caldarice.

"The effects of climate change are not uniform in their reach or magnitude – nor are the abilities of countries and communities to cope and respond"

United Nations. World Social Report 2020: inequality in a rapidly changing world.

INDEX

LIST OF FIGURES, TABLES AND MAPS

ABSTRACT

Cities are the most impacted by climate change, yet they are the largest contributor to its impacts. Nowadays more than 50% of the global population lives in cities and in less than three decades nearly two-thirds will reside in urban areas. Since the goal to keep the temperature increase to 1.5 °C is still far-reaching, cities must identify the urgent pathway to leverage their adaptation while acting proactively with stakeholders and the community in order to deal with the current and future effects of climate change. This master thesis aims to understand how cities can adapt to climate change by transforming urban spaces to cope with climate hazards, specifically by understanding if Urban Climate Shelters are an effective way to resolve the intricate interplay between policy and practice. Moreover, the research study explores an innovative project that aims to transform schoolyards from traditionalist approaches, based on impervious surfaces and low-albedo materials, to more sustainable, natural, and resilient approaches that are beneficial for adapting cities to climate change, as well as the quality of life and health of citizens. In addition, the thesis provides benefits for the whole community, where it preserves the use of the schoolyard for educational purposes, although in non-school hours and in summertime the schoolyard is open for the public, providing a climate shelter for everyone and increases access to green areas. To deepen the concept of climate shelter in different European contexts, were first analyzed six cities that successfully implemented the project in the last decade (Madrid, Barcelona, London, Paris, Amsterdam, and The Hague) and, secondly, two front-runner cities that UIA financed to transform ten schoolyards: Paris and Barcelona. Additionally, considering the non-existence of common terminology and that each city provides a unique nomenclature, one of the first goals of this study was to establish the concept of URBAN CLIMATE SHELTER (UCS) that can be defined as a space that provides features for the adaptation to climate change, fostering security from the heat, flood, and droughts, through a multi-hazard approach by using green and blue infrastructures, together with the process of co-design with local stakeholder. Additionally, guidelines with six principles were developed for the successful implementation of UCS: (i) map hazards; (ii) map needs; (iii) select space; (iv) engage co-designing; (v) design elaboration; (vi) ensure upscaling. Finally, the guidelines were tested on a pilot case, in Turin, Italy, a city characterized by highly impervious and prone to climatic hazards such as heat waves and flooding. The selected space for the intervention was the Valdocco area, a neighborhood that is being renovated into a more livable and resilient area following the strategic plan of the city. Nevertheless, in the upscaling perspective (vi) and through qualitative analysis, 610 other schools were identified in the city to be potentially transformed by 2050, meeting the European goals. Concluding, the recommendations state that starting the transformation by schools is a preliminary pilot since it involves numerous key stakeholders and provides awareness of climate change from an early age. However, the upscaling process should go beyond schoolyards involving other sectors and facilities, subsequently fostering resilient and shelter cities.

KEY WORDS:

URBAN CLIMATE SHELTER

ADAPTATION TO CLIMATE CHANGE

URBAN RESILIENCE

SCHOOLYARDS REGENERATION

CO-DESIGNING

NATURE-BASED SOLUTIONS

CHAPTER 01.

INTRODUCTION

INTRODUCTION

Background

Notably, the world has been changing in the past decades, according to UN more than half of the world's population are nowadays living in urban areas, and by 2050 the world's population is expected to nearly double and potentially reach two-thirds of its populations in urban areas, as a matter of fact influencing and directly accelerating the climate hazards. Along with, the necessity of reshaping the course of action that cities have been developing. Subsequently, due to this necessity terms such as sustainability and resilience started to appear and be applied within the urban context. Urban resilience in particular is an ambiguous tool for the development of the cities, thus by improving the city's capability to adapt, differently from sustainability, urban resilience develops strategies for a short-term period (Brunetta and Caldarice, 2020).

Statement of the problem

Furthermore, two types of risk can be encountered, natural and anthropological ones (Meerow et al., 2016). Thus, accordingly representing the effects of global warming and climate change. In other words, the world is inevitably changing in its natural way, however, the effects of urbanization, such as soil sealing, logging, misuse of natural resources, and so on, are accelerating the process of global warming. Clearly, facing such a reality, it is possible to understand the necessity of change and adaptation. Moreover, cities all over the globe are including adaptation plans in their process of development, the main challenge nowadays is to tranform these policies into practice, chasing materiality.

Rationale and justification of the study

Subsequently, spatial planning has a vital role in the adaptation to climate change, yet, the necessity of change also is related to the social aspect, meaning that not only public or private sectors should be involved with the process of spatial planning, however, the participation of communities and individuals is also essential for the fruition of the same. Additionally, spatial resilience walks hand in hand with bottom-up practices that integrate institutional policies (Meerow & Newell, 2019a). In this research, one of the main objectives is to understand and improve the innovative project of Urban Climate Shelter. The innovation represents the shift from policy to practice, as well as the social involvement and co-production in the process of implementation. Moreover, the study executes reliable case study analysis, approachable guidelines on how to implement Urban Climate Shelters, and realistic pilot application in Turin, Italy.

Research questions

The study seeks to comprehend Urban Climate Shelter in the context of Europe. It is structured with a primary question and several supporting questions that offer specific information on:

Are Urban Climate Shelters an effective way to resolve the interplay between policy and practice to integrate climate action into planning?

To begin with the theoretical framework on the understanding of "What challenges are being faced by cities nowadays? How cities adapt to climate change? And how spatial planning can support the adaption?". Secondly, within scientific literature and grey literature the of the innovative project about Urban Climate Shelters "What is Urban Climate Shelter? How are Urban Climate Shelters in policy and practice? What are the strengths and weaknesses of the same?". Moving forward to the case study and best practices of the city of Barcelona and Paris, accordingly, observe "How the cities have implemented its Urban Climate Shelters in the cities? As well as what strategies and solutions have been proposed?". Subsequently, the proposal of abacus guidelines for the Urban Climate Shelters "What are the planning and design features necessary to implement Urban Climate Shelters? How can the guideline address multi-hazard approach for adapting to climate change?". Last, the proposal for urban climate shelter in the Valdocco neighborhood in Turin, Italy, therefore acknowledges "What are the analysis necessary for the implementation of Urban Climate Shelter in practice? How does the use of the guideline work in practice?"

Are Urban Climate Shelters an effective way to resolve the interplay between policy and practice to integrate climate action into planning?

1. "What challenges are being faced by cities nowadays?"

2. "What is Urban Climate Shelter?".

3. "How cities have implemented its Urban Climate Shelters?"

4. "What are the planning and design features necessary to implement Urban Climate Shelters?"

5. "What are the analysis necessary for the implementation of Urban Climate Shelter in practice?"

Literature review

The methodology applied on this study followed the scientific and grey literature, considering the lack of information on the academic literature referring to Urban Climate Shelter, the use of plans and reports was essential for the holistic approach of the topic. Moreover, executing a literature review was challenging considering the first attempts either resulted into no results or too broad of a topic such as climate change and hundreds of articles. Furthermore, the attempt using key words such as adaptation, climate change, cities and shelter, followed by sub key words corresponding to climate shelter, urban cooling island, school, resilience, public spaced and schoolyard, resulted into 11 articles. In addition the search was framed from 2010 to 2023 to ensure the use of up-to-date content.

The literature review:

(TITLE-ABS-KEY ("climate change" AND adaptation AND city AND cities AND shelter) AND TITLE-ABS-KEY ("climate shelter" OR "urban cooling island" OR school* OR resilience OR "public space" OR "schoolyard" OR heat)) – 2010 to 2023.

Hypothesis

The concept of climate shelter is quite recent, it is possible to say that there will be a lack of information related to it, therefore, the first challenge will be to create the framework and taxonomy on this new topic, and to understand the opportunities and the weakness of climate shelters. However, it is possible to have an understanding since not only one, but six different European cities have similar project related to adapting urban spaces for climate change. Moreover, the abacus guideline will be an onward project, where it will be refined and meliorated as newer innovative projects appear.

Objectives

Firstly, the objective of this research is to provide a shift in the current overview of the adaptation of cities related to climate change. Consequently, analyzing the good examples in the case study and refining it for a better result, thus, by including on the abacus guidelines for the Urban Climate Shelter not only the adaptation to heat but other threats such as floods, and droughts. Subsequently, providing a practical result in the city of Turin, addressing many climate threats on a vulnerable European neighborhood, consequently, addressing many solutions, proportionating the analysis of the area and the implementation of the research acquired.

Scope and boundaries of the study

Firstly, the initial focus is to limit the research on the cities' adaptation to climate change, addressing the importance of the shift from policy to practice, as well as the essential tool of the community co-production. Subsequently, the study on Urban Climate Shelter works accordingly to the previously stated, acknowledging the difficulty of conceptualization of the same, therefore, framing the European context according to the literature review. As a result, focusing on the understanding of the phenomenon through six cities for case study, such as, London, Paris, Madrid, Barcelona, Amsterdam, The Hague, hence, acknowledging Paris and Barcelona as best practice, due to the amount of information available, number of schools transforming, and effective upscaling process of the project. Another constraint is the emphasis on schoolyards, which highlights the advantages for academic achievement and child growth milestones, as well as the co-production of important stakeholders who involve the school community, increases the importance of the participation process. Finally, the practical phase of the research will be focusing on the city of Turin, recognizing its similarity with the other case studies, hence urbanization complexity, climate hazards, city size and population, and the need of implementation projects. Nevertheless, being aware that Urban Climate Shelter can be a worldwide answer for adaptation to climate change.

Potential for a follow up

Finally, acknowledging the recent innovative project on urban climate shelters, this research could be better developed within time, thus, by ameliorating the guidelines including new features as time goes by and newer projects are developed. Therefore, another option could be to include broader research on different continents, understanding if the same solution has been created and if so, how is it conceptualized and implemented. The objective is to explose these solutions and as time goes on, it would be interesting to apply the abacus in different cities and neighborhoods to see how it can be improved and to help cities use UCSs to adapt to climate change.


THEORETICAL FRAMEWORK
FIRST PHASE
Rationalization of the problem related to cities and climate change
Addressing urban resilience, adaptation to climate change and disaster risk reduction on the Urban Climate Shelter context
Conceptualization and definition of terminology Urban Climate Shelter
CASE STUDY AND BEST PRACTICES
SECOND PHASE
Understanding of European context related to Urban Climate Shelter in Madrid, London, Barcelona, Paris, Amsterdam and The Hague
Analyzing the challenges and strategies for the development and implementation of Urban Climate Shelter in Paris and Barcelona
GUIDELINES AND PILOT
THIRD PHASE
Development of guidelines for Urban Climate Shelter
Pilot implementation of Urban Climate Shelter guidelines in Turin

BOUNDARIES OF RESEARCH
EUROPE

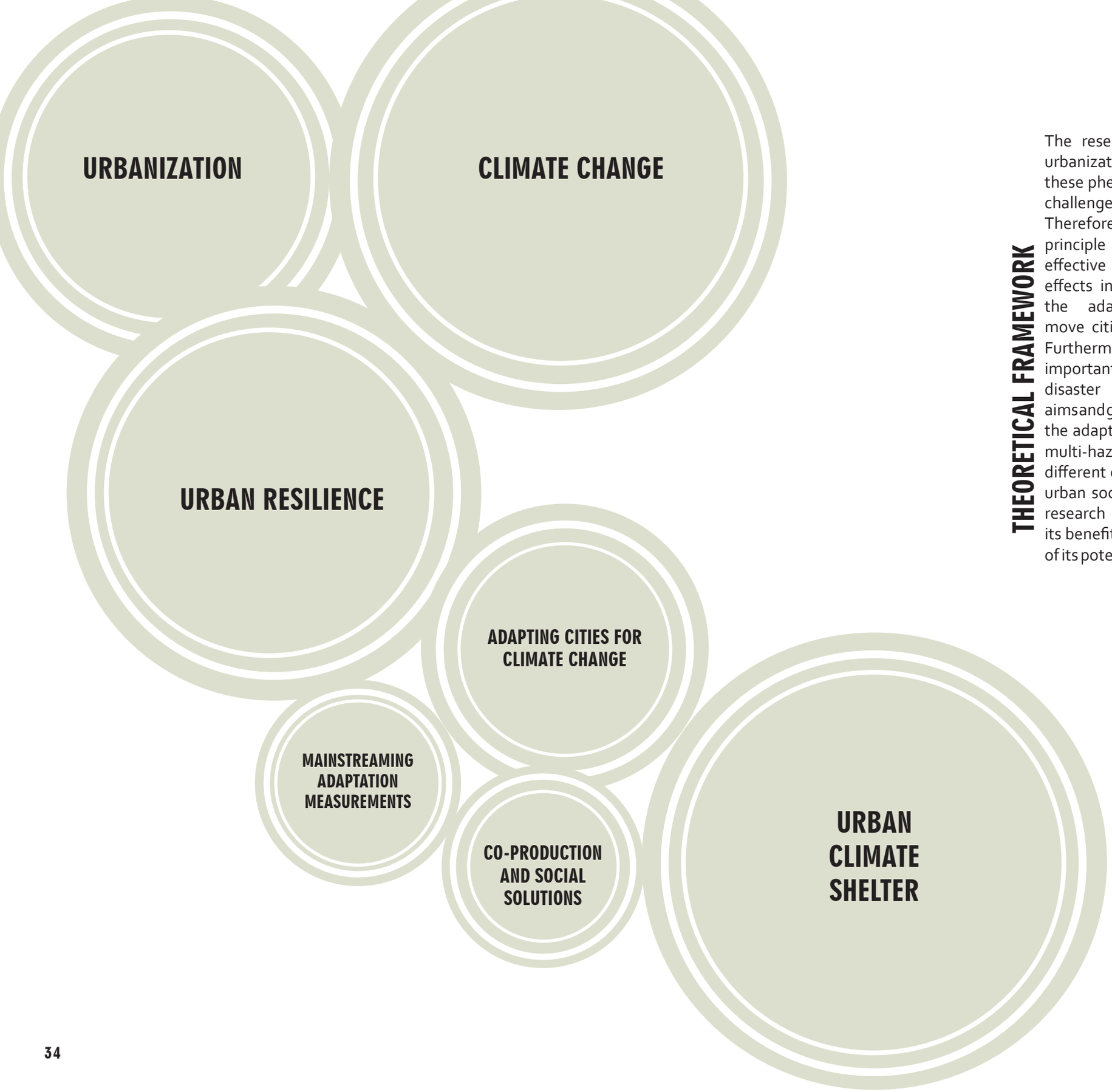
SIX CASE STUDIES
BARCELONA, PARIS, MADRID, LONDON,
AMSTERDAM, AND THE HAGUE

TWO BEST PRACTICES
PARIS AND BARCELONA

ONE PILOT
TURIN

CHAPTER 02.

THEORETICAL FRAMEWORK



THEORETICAL FRAMEWORK

The research follows the challenges faced by urbanization, moreover the impacts caused by these phenomena, such as the increase in climate challenges due to human transformations. Therefore, in order to tackle the issue the main principle addressed is urban resilience, an effective way to manage climate change effects in cities. In addiction to acknowledge the adaptation initiatives already existing to move cities to a sustainable and resilient path. Furthermore, three-course of actions are very important to achieve such goals, thus, including disaster risk reduction matters and its aims and global policies, followed by mainstreaming the adaptation measurement, in order to address multi-hazard approach considering cities can face different climate hazards, with co-production and urban social solutions process. Subsequently the research focuses on Urban Climate Shelter, and its benefits and challenges and the understanding of its potential to guide cities to a resilient pathway.

URBANIZATION

Currently, the world's population living in urban areas has overtaken the population living in rural area, therefore, more than 55% of humanity live in urbanized area, furthermore in Europe nowadays 73% of inhabitants live in the cities expecting to achieve 82% in less than 3 decades. Considering the rapid growth of major urban centers, by the year of 2050 over 65% of the global people are projected to be living in urban and peri-urban areas. In consequence, urban areas have a major impact on the global sphere, responsible for more than two-thirds of CO_2 production, as well as more than half of global waste and the consumption of three-fourth of natural resources . Undoubtedly, cities are the major actors for change, and number one provider of solutions for the recurrent threats and disasters, such as social inequalities, energy safety and climate change (United Nations, 2018).

CLIMATE CHANGE

Duo to irresponsible usage of global natural resources, unsustainable practices on energy and land use, as well as way of living, human activities are therefore responsible for the acceleration of the global warming (IPCC, 2023). Future climate prediction demonstrates numerous hazards to human life, one of them being the urban heat island (UHI) characterized by higher temperatures in urbanized areas than in its surroundings, thus, caused by an increase of global heat waves (Orsetti et al., 2022). Furthermore, in the upcoming decades the global temperature is estimated to increase by 2-8it°C, considering 8 degrees in the most vulnerable areas such as parts of Africa, consequently an increase on the drought's day yearly and insufficient water supply (Lin et al., 2021). The continued atmospheric pollution through greenhouse gas over usage will impact directly in the increase of global warming (IPCC, 2023). Human actions are provenly to be the main cause of greenhouse gas emissions. Nevertheless, vulnerable communities even if causing less impact to global warming, have been affected the most. Climate change is directly associated with healthy issues, impacting on air pollution and human well-being, in addition to increase human mortality by heat (Orsetti et al., 2022). Therefore, the process to slowdown global temperature, must be sustainable, fast, and effective, especially the reduction of greenhouse gas emissions. By providing climate resilient solutions to the adaptation and mitigation of climate threats, as well as following a sustainable development, cities could achieve positive results within few decades. Moreover, actions taken now can possibilities impressive results for the amelioration of global warming for this and the upcoming centuries (IPCC, 2023).

55% **of humanity living in cities 2023**

82% **of humanity will live in cities in 2050**

3% **of world`s land coverage are represented by cities**

60/80% **of world`s energy consumption happen in cities**

75% **of carbon emissions occur in cities**

URBAN RESILIENCE

Urban resilience is a complex term that has been studied in the last decades in diverse contexts. Nevertheless, on the spatial context resilience can be defined as the ability of a city, a neighborhood or any system to overcome its basis after an unexpected event, thus, including material and immaterial conditions (Meerow & Newell, 2019). Moreover, urban resilience stresses the fact of uncertainty future, events and risks, so it aim to built a capacity to adapt to the unpredictable scenarios. Urban resilience in particular is an guide principle for the development of the cities, thus by improving the city's capability to adapt, differently from sustainability, urban resilience develops strategies for a short-term period (Davoudi et al., 2012). Additionaly, urban resilience provides solutions through adaptation and mitigation in cities, taking into consideration the challenges of urban growth and embracing reduction of disaster risk. Adaptation responses include the reduction of heat waves, improvement of air quality, reduction of greenhouse gas emissions, improving water management, as well as including vulnerable population, more importantly how to manage such complex disasters faced by cities (Orsetti et al., 2022). Strategies such as green infrastructure enhance resilience and the ability to adapt to multiple hazards, therefore, by providing cooling solutions coping with urban heat island, as well as through natural matter increasing the absorption of water in the soil, therefore decreasing the occurrence of runoff water (Meerow & Baud, 2012). Without a doubt, the path is to identity the correct measurements on how to achieve the balance in between ecosystems and urban population (Caldarice et al., 2021). Therefore, providing strategies such as to achieve global net zero CO_2 emissions by 2050, collaborating for the limitation of 1.5°C of global warming, through fast and immediate solutions (IPCC, 2023). Although, strategies implemented nowadays, if not taken in consideration worldwide will not be enough to decrease global warming. Further and foremost, in order to provide effective results, adaptive solutions to climate change crucial measurements are needed, such as providing replicability, flexible and cost-effective alternatives (Fares et al., 2021). Moreover, stressing the importance of planning strategies that provide co-benefits for the society in a health, environment, and economic matter (Davoudi, 2014). While the concept of urban resilience has been explored from various angles, it offers limited comprehensive aspects and poses challenges to the implementation of policies and programs aimed at measuring and achieving resilience. "Resilience is a challenge for urban planning and not a fixed attribute for the system" (Brunetta et al., 2019., p. 10) In this context, a new concept, territorial resilience has been introduced. This concept not only enhances the ability of cities to cope with climate events but also introduces the governance sphere in resilience considerations. Moreover, it facilitates the decision-making process by identifying vulnerabilities and transforming socio-geographical areas. To effectively measure resilience as a complex phenomenon, there is a need for the introduction of a comprehensive multicriteria approach to spatial analysis, encompassing multidisciplinary perspective, cultural and community dimension, and considering temporal progression as a co-evolutive process (Brunetta et al., 2019).

ADAPTING CITIES TO CLIMATE CHANGE

Postponing adaptation and mitigation actions globally can result in deep loss for human life and ecosystem. Actions should be taken fast in a resilient and sustainable matter, envisioning the conscious usage of natural resources for the future generations, and providing adaptation and mitigation for hazards happening nowadays, therefore, collaborating for short and long-term results (IPCC, 2023). Importantly, it is visible the implementation of the adaptation processes in urban areas throughout the world. Effective measurements such as the Paris agreement, the New Urban agenda and the Sendai Framework have helped guiding cities through a resilient path (Making Cities Sustainable and Resilient Campaign: Implementing the Sendai Framework for Disaster Risk Reduction 2015 – 2030 at the Local Level, 2015). The 17 sustainable development goals provided by the New Urban agenda have different targets and solutions, the SDG 11 more specifically provides a clear understand of the climate hazard within urban areas. It aims to provide spatial resilience, promoting capability to cities to adapt to climate change, as well as other hazards for cities such as population growth and poverty (Filho, 2020). Embracing climate change awareness in different contexts has resulted in the inclusion of adaptation plans and policies in 170 countries. European cities are experimenting with planning and designing solutions to reduce Greenhouse Gases (GHG) emissions and to contrast the impacts of climate-induced extreme events, including the challenges posed by rising temperatures and the intensification of the Urban Heat Islands (UHI) effect (Salvia et al., 2023). Despite the current cities' efforts, integrating climate mitigation and adaptation actions locally needs to be improved. As evident from the NDC analysis (2022), climate action at the local level in Europe is missing and it continues to deal with many gaps and challenges for governments in developing their adaptive capacity. The integration of climate action at the local level requires multi-level governance to enhance institutional and technical capacities, and the availability and direct management of financial resources, with varying levels of direct investment from local governments. Additionally, multi-level governance expects to develop plans to implement mitigation and adaptation actions, continuously modify policy and practice, and exploit any arising opportunities (Barth, et.al., 2022). In addition, European cities are starting to face the heat problem by introducing different projects to transform critical urban spaces – parks, libraries, and civic centres – into climate shelters where residents can take refuge during extreme temperatures (Amorim-Maia et al., 2023). Such solutions have been recognized as relevant strategies in responding to climate risks due to their multifunctional and cost-effective nature (Mallen et al., 2023). In this scenario, a growing interest focuses on initiatives to transform schoolyards into refuges during extreme temperatures. The few European experiments are generally based on nature and implemented through co-designing approaches (Giezen & Pellerey, 2021; Vetter, 2020).

Paris agreement

Sendai Framework for Disaster Risk Reduction

The New Urban Agenda

17 Sustainable development goals

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable

SDG 13: Take urgent action to combat climate change and its impacts

MAINSTREAMING ADAPTIVE MEASURES

Strategies are needed in order to achieve positive results on adapting cities to climate change, thus, more importantly it is the integrability of these strategies, such as combining different solutions, therefore technological, nature-based and social solutions (Lin et al., 2021). Moreover, integrating more than one solution permit to tackle different hazards and issues in the same multi-functional strategies, acknowledging the complexity of an urban area and human population (Caldarice et al., 2021). To illustrate technological solutions are related to the choice and use of different material, for example pavement choices are more affective when and permeable material therefore coping with flooding or run-off water, absorbing precipitation. Furthermore, another advantage provided by technological solutions refer to reduce heatwaves, by selecting material that have a lighted color, therefore increasing the albedo of different surfaces, for instance roof, pavement, and walls. Nature-based solutions produce multi-functional benefits for the adaptation to climate change, including restauration of biodiversity, environmental awareness, and improvement of human health (Baró et al., 2022). NBS if defined by the European Comission as "solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience" (European Commission, 2016, p. 1) (Raymond et al., 2017). Besides the use of vegetation for example, nature-based also include blue and green infrastructure solutions that foster the creation of ecosystem services. Additionally, as well known to achieve resilient results for adaption and mitigation of climate change in the next decades it is necessary to reduce global atmospheric emissions, therefore, nature-based are key solutions that contribute hardly for the achievement of this goal ("What are nature-based solutions and how can they help us address the Climate Crisis?",2020).In fact, more than 30% of the results needed by 2050 working in hand with the Paris agreement can be provided by nature-based solutions. Importantly, the implementation of nature-based solutions needed deeply understanding of the context, not simply the plantation of trees, the usage of non-local vegetation can implicate into harmful results for the biodiversity, therefore, the essential knowledge about the context environment ("Climate Explainer: Nature-based solutions",2017). NBS beneficiates not only the natural environment but as well as the wellbeing of human population (World Wildlife, 2021). Furthermore, nature-based solutions due to its multi-functionality on addressing different issues, contribute to economical gain. Therefore, addressing the last of the three solutions mentioned above, where includes the urban social aspect. Finally, urban social solutions incentive multi-stakeholder involvement, working on a local level, by understanding the need of each community and fostering together strategies to adapt to climate change, moreover, the engagement and co-production on the practical work (Lin et al., 2021).

CO-PRODUCTION AND SOCIAL SOLUTIONS

One of the biggest challenges for achievement of urban resilience when adapting cities to climate change is the shift from policy to practice. Therefore, promoting the participation of different stakeholder on the process of co-design and co-production, provides the effectiveness of moving forward from policy making to achieving results (Mitlin, 2008). The science policy and practice are a powerful tool to development. Moreover, this process should be circular encouraging the involvement of the stakeholders in all the different processes of development and implementation. Nevertheless, the integration of co-production encounters various difficulties within different types of planning systems. This highlights the growing need for a deeper understanding of co-production in urban governance. Additionally, co-production measurements emerge as essential tools in the context of good governance (Bragaglia et al., 2023).

TERMINOLOGIES BY CITY:

BARCELONA

Climate Shelter
"Refugio Climático"

MADRID

Healthy School Environment

Caring for Public Spaces in Schools

School Surroundings

LONDON

Climate Resilient Schools

PARIS

School OASIS

THE HAGUE

Green School Squares

AMSTERDAM

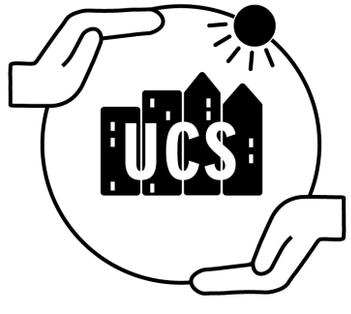
Greening School Playgrounds in Amsterdam

Amsterdam Impulse Schoolyards

URBAN CLIMATE SHELTER

In order to acknowledge the global reality addressing climate change, as well as the challenge when dealing with urban settlements new research, projects, strategies and solutions are being created all over the world constantly by urban planners, researchers and public administration. Nevertheless, in this research the focus will address the European context, providing an understanding of a specific strategy used by different cities to cope with hazards and disasters, to achieve a sustainable and resilient future for urban population. The project that will be unfolded in this master thesis is the urban climate shelter, this inventive project is being implement in the last decade by many different cities in Europe. Since is a relatively new approach the definitions for it have not been defined yet, so far, many names have been cited such as climate shelter, climate refugees, urban cooling island, climate resilient schools, and, school's oasis. Furthermore, considering the focus on European cities, more specifically the cities of Madrid, Barcelona, London, Paris, Amsterdam, and The Hague. Each of these cities has created its own nomenclature for the project, however, their different strategies have all the same goal, adapting cities to climate change (Vetter, 2020). Moreover, it is important to inform that some terminologies have been adapted to the English language, since the original languages were Spanish in case of Barcelona and Madrid. The other cities such as France, Amsterdam and The Hague use the English terminology despite the fact of having another mother language. Firstly, climate shelter is defined as a natural space where animals use to hide from the weather events (Ramon, 2022). However, in the spatial planning context climate shelter is a new term used by the city of Barcelona to refer to a cooling public space that provides thermal comfort for residents and tourists (Vetter, 2020). The city of Madrid used multiple terms, such as healthy school environments, caring for public spaces in schools and schools' surroundings, where refers to adaptation measurements for climate change, by transforming schools' immediate, proximate surroundings as well as the schoolyard (De Madrid et al., 2016; Serrano et al., 2017). Climate resilient schools refers to the terminology defined by the city of London to describe the project of adapting schools to the impacts of climate change ("Climate resilient schools", 2023). Paris defined the project as school Oasis, where it refers to Openness, Adaptation, Sensitization, Innovation and Societies, the idea of a cool island by adapting to climate change through school-based initiatives (Sitzoglou, 2020). Greening school playgrounds in Amsterdam / Amsterdam Impulse Schoolyards (AIS) are a public initiative by the municipality of Amsterdam to transform the playgrounds of the primary schools across the city (Disch EDisch & Projectmanager AIS, 2018). Finally, The Hague create the Green School Squares with the aim to proportionate easier access

to nature to the children living in urban area ("Developing cooler, greener schoolyards across the city", n.d; "Schoolyard the Hague", n.d) Furthermore, considering that climate shelter has its roots in a natural context, in this research the terminology used to define the phenomenon will be Urban Climate Shelter, which includes the natural principle of a climate shelter but is implemented in an urban context. **URBAN CLIMATE SHELTER (UCS) can be defined as a space that provides features for the adaptation to climate change, providing security from the heat, flood, and droughts, through a multi-hazard approach by using green and blue infrastructures, together with the process of co-production of local stakeholder.** First and foremost, transforming schoolyards into a greener environment has turn into a common strategy by planners to adapt to climate change, as well as hazards such as heat, flooding, and precipitation. Therefore, as considering schoolyards a public asset when referring to public schools, the improvement of the areas has a beneficiary for the whole municipality and community, thus, considering that schoolyards are a considering high amount of open space in relation to the city as well as evolve diversity on city population users, such as students, parents, professors, as community in general. Therefore, explaining the usage of this space contributing for multi benefits, for instance, environmental and social (Flax et al., 2020). Scaling up of UCS has benefits not only for the school environment itself, contributing as well to the biodiversity, and the decrease of global climate disasters. Important processes were necessary on the development of UCS in Europe, some of the cities mentioned followed two main steps in order to provide co-design. The first one is the understand of current stages of the schoolyards, therefore, to provide effective design solutions. The second, is the co-production of different stakeholders on the decision making of the design features, therefore discussions, meetings and idea setting. Moreover, the projects incentive the use of blue and green infrastructures, although the use of grey infrastructure is also present, for instance the use of solar panels as a tool to provide sustainable energy production, and the use of different materials for the provision of shaded areas (Baró et al., 2022). The city of Paris and Barcelona have been given the funding by European Union through Urban Innovative Action project to transform a limited number of schools, however, according to municipal plans, both cities have the intension to provide replicability in more schools. Both cities have already started the upscaling, where Paris has a plan to transform all public schools by the end of 2050. Considering the city of Barcelona, the green schools inequalities existent should be taken into consideration when upscaling in different schools. Subsequently, one of the requirements by the UIA project is to enhance the usage of the schoolyards as a public space, where multi users, especially the ones in vulnerable conditions can have access to the space as a cooling area, in order to provide accessibility to the whole community schoolyards are open for the public during summertime and after school hours (Antoniadis et al., 2020; Baró et al., 2022). Moreover, the city of Amsterdam addresses the same concept, opening schoolyards after school hours, as well as promoting the upscaling to more schools (Antoniadis et al., 2020). Incorporating NBSs to transform schoolyards into UCSs is a promising path to boost multiple co-benefits from urban nature and climate change mitigation and adaptation to enhanced health, well-being, and social justice for all citizens, in particular children and those mainly vulnerable to extreme heat (Baró et al., 2022; Flax et al., 2020). Turning schools into UCSs is strongly urged, as schools can perform as cooling "demonstration projects" for climate mitigation and adaptation, benefiting cities and communities in heat reduction and restoring urban ecosystems using NBSs. At the same time, the implementation challenges and European upscaling opportunities for UCSs in schoolyards still need to be systematically understood and tested in practical case studies.



SCHOOLYARDS

Moreover, according to C40 report on cooling schools there are 6 main reasons to transform schools in order to cope with extreme event, this as following:

1. Children are particularly vulnerable to extreme heat.
2. Cooling the indoors of school buildings (ideally with passive design, shading and natural ventilation features) increases the thermal comfort and creates a better learning environment.
3. Creating schoolyards with enough shaded areas encourages children to play outside and increases physical activity in breaks.
4. Using schools as community hubs can bring heat-awareness to homes and parents.
5. Schools are often owned by the municipality and can function as demonstration projects of cooling features on buildings (green roofs/ walls, shading, water features etc.) that can be distributed throughout the city/neighborhoods.
6. Schools can even act as 'cool islands' (cooling centers) that can be opened to the public on weekends in heatwaves periods (Vetter, 2020, p. 2).

Schoolyard are generally predominantly paved by materials with high absorption of heat, such as asphalt and cement, therefore schoolyards are a hazard for children during extreme hot weather. Heat events are hazards for human health and well-being, especially for children since they are considered a vulnerable group (Antoniadis et al., 2020). Nevertheless, foster safeness to all human beings, in particular to vulnerable groups such as women, children, and elderly are one of the targets of the Sustainable development goal 11 (Baró et al., 2021). The benefits from providing contact with green spaces go beyond environmental issues, it promotes stress reduction, decrease of air pollution, improvement of SDQ (Strengths and Difficulties Questionnaire) score, and decrease of ADHD (Attention Deficit Hyperactivity Disorder) and inattention symptoms, undoubtedly contributing to human mental well-being (Amoly et al., 2015). Subsequently, providing green areas in schools lead to better behavior, an improvement in skills such as creativity and social interaction, and an increase on the academic achievement (Amoly et al., 2015; Kuo et al., 2021). Besides the physical gain by increasing playing or leisure time in a pleasant environment, before, during and after the school hours (Baró et al., 2021). Additionally, considering that historically schoolyards have not been given enough attention and importance in the school environment, providing this shift enhance awareness to climate change in urban context. Enable the choice of the use of correct material can increase the albedo of the schoolyard, the use of vegetation contributes for the micro-climate of the school area, creating a cooling area that reduces the absorption of radiation in human bodies, fostering thermal comfort (Antoniadis et al., 2020). Moreover, as stated schoolyards provide a great potential with multi-functional benefits for the adaptation climate change in urban areas. Through integrative strategies enabling solutions addressing different hazards such heat, flood, and drought. Moreover, taking into consideration that challenges related to climate change are a global issue, additionally with the wrong choice of material for schoolyards the replicability of the Urban Climate Shelter can be done in most European cities as well as worldwide. Furthermore, the reproducibility can provide a shift on the perception of public assets, where public school yards are not only accessible only by students and teachers, but the whole community in non-school hours, therefore, this initiative creates more open green spaces for the urban areas (Cartalis, 2020). Therefore, contributing for the adaptation of cities to climate change, by transforming existing spaces that have not been built before with sustainable and resilient intensions and infrastructure.

BEYOND SCHOOLYARDS

This research has a boundary of focus on schoolyards, although acknowledging the similar issue present in other public spaces, such as parking lots, squares, libraries, and hospital yards, the potential of the implementation of the Urban Climate Shelter goes beyond schoolyards. Consequently, schoolyards might be just the starting point of community awareness of climate change, and co-production initiatives transformations at the city scale.

CHAPTER 03.

CASE STUDIES

MADRID, LONDON, BARCELONA, PARIS, AMSTERDAM AND THE HAGUE.

BEST PRACTICES: PARIS AND BARCELONA

The next chapter of this research is dedicated to a better understanding of the projects carried out by the city of Barcelona and Paris, two European cities that have similar issues such as high levels of urbanization, high density, and high temperatures, moreover, two cities that have already implemented Urban Climate Shelter in the past years and that are continuously implementing more. Foremost, the analyses were carried through observation of materials available from grey literature such as plans, reports, and implementation images.

CASE STUDY ANALYSIS

	PROJECT NAME	POPULATION	PROJECT BEGINS	FUNDING AGENCY	MAIN CLIMATE HAZARDS	SECTORIAL PLANS AND POLICIES RELATED TO CLIMATE CHANGE
BARCELONA	Climate Shelter / Refugee	1.6 million inhabitants – 101.3km² 3.2 milling inhabitants – metropolitan area	2020	Urban Innovation Actions	Heat	The climate shelter project journal; Project refugis climàtics; Green infrastructure and biodiversity plan 2020; Barcelona Climate Plan
PARIS	School Oasis (O-peness, A-daptation, S-ensitization, I-nnovation, S-ocialties)	2.1 million inhabitants – 105,4km² 13 million inhabitants – metropolitan area	2018	Urban Innovation Actions	Heat	The Oasis schoolyard project journal;Paris Climate Action Plan; Paris Resilience Strategy
MADRID	Healthy school environments / Caring for school environments / School surroundings	3.2 million inhabitants – 505 km² 6.7 million inhabitants – metropolitan area	2018	Public initiative	Heat	Guia diseno entornos escolares; Entornos escolares saludable; Recovery, Transformation and Resilience Plan Madrid
LONDON	Climate resilient schools	8.9 million inhabitants – 1.572 km² 14.8 million inhabitants – metropolitan area	2020	Private and public partnership	Drought Flood Heat	How London schools and early years setting can adapt to climate change; Resilience Strategy 2020; The London Plan
AMSTERDAM	Greening school playgrounds	1.4 million inhabitants – 219,3 km² 2.4 million inhabitants – metropolitan area	2020	Perfect Interreg Europe	Flood	Greening school playgrounds report; Green Infrastructure Vision 2050; Strategy for climate adaptation
THE HAGUE	Green School Squares	514 thousand inhabitants – 130,2 km²	2011	Fonds 1818 Private initiate	Flood Heat	Memorandum on Sustainability: Clean energy in a green city; Resilience strategy

BARCELONA

Climate Shelter / "Refugio Climático"

1.6 million inhabitants – 101.3km²
3.2 milling inhabitants – metropolitan area
37.4C highest temperature registered in August of 2010

•Urban Innovation Actions project
•Private and public partnership
•Beginning of implementation: 2020
•Main target: Heat
•Duration: 3 years of sponsorship by Urban Innovative Actions
•11 schools transformed by Urban Innovative Actions
•29 new schools by the end of 2023
•202 climate shelter nowadays, beyond schools

• Sectorial plans related to climate change
- The climate shelter project journal I and II
- Project refugis climàtics
- Green infrastructure and biodiversity plan 2020
- Barcelona Climate Plan

•Partnerships
- Urban Ecology Area
- Social Rights Area
- Barcelona Public Health Agency (ASPB)
- Barcelona Water Cycle, Energy Agency (BCASA)
- Barcelona Education Consortium
- UAB Institute for Environmental Science and Technology (ICTA-UAB)
- Barcelona Institute for Global Health (IS Global)
- School community

The city of Barcelona provided a clear statement and understanding of the process and outcome of the project. 'Refugés climaticos' or climate shelter in English is a project financed by the European Union in order to reduce the deaths in the city related to the heat, since Barcelona, such as many other cities has been facing warmer summers. The project began in 2020, with the idea to provide a climate shelter in a 10-minute walkable space, the shelter was implemented mainly in schools, thus, with the collaboration of many stakeholders. The public spaces are devoted to welcoming anyone struggling with the heat, but more importantly to protect the most vulnerable population, such as the elderly and children. Therefore, justifying the use of schools as climate shelters (Cartalis, 2020a, 2020b; GBG_AS2C - Blue, Green & Grey_Adapting Schools to Climate Change | UIA - Urban Innovative Actions; Project Refugis Climàtics; Vetter, 2020).

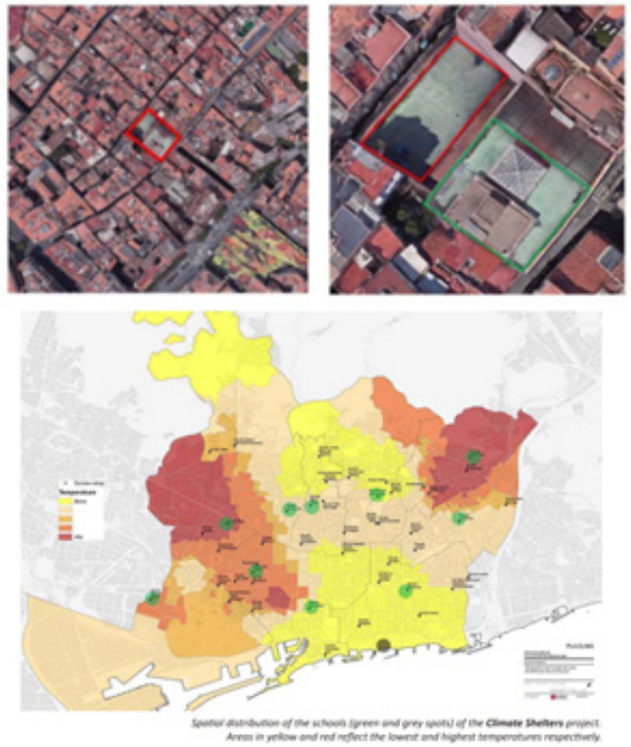


Figure 1: Barcelona's schools selected and differentiating building mass and schoolyard. Source: Barcelona's Pilot Project to Beat the Heat and Project Refugis Climàtics.

PARIS

School Oasis (O-peness, A-daptation, S-ensitization, I-nnovation, S-ocialties)

2.1 million inhabitants – 105,4km²
13 million inhabitants – metropolitan area
42.8C highest temperature on 25 July 2018

•Urban Innovation Actions project
• Public and Private partnership
• Beginning of implementation: 2018
• Main target: Heat
• Duration: 3 years of sponsorship by Urban Innovative Actions 2019-2021
• 3 schools 2018
• 18 schools 2019
• 10 schools 2020 transformed thought Urban Innovation Actions sponsorship
• 760 public schools by 2050

• Sectorial plans related to climate change
- The Oasis schoolyard project journal 1
- Oasis schoolyards maintenance guide
- A new way to renovate schoolyards
- Paris Climate Action Plan
- Paris Resilience Strategy

•Partnerships
- City of Paris
- ESIEE - higher education and research institute
- LIEPP - higher education and research institute
- CAUE de Paris - Architecture, Urban Planning and Environment public service provider
- Ligue de l'enseignement - Federation of Paris (LIGUE) - education association
- Meteo France - meteorological and climatological institut

The city of Paris created the Oasis schoolyards project, according to Sitzoglou (2020) Oasis project aims to transform all schoolyards in Paris into urban cooling islands. The aim is to provide permeable grounds, more vegetation, water points, creative games adapted to different needs, quiet spots, and a better distribution of space. In addition, the maintenance guide for the Oasis schoolyards includes four different guidelines for maintenance including ground, greenery, and furniture. Moreover, the project started in 2018, with UIA sponsorship to transform 10 schoolyards in order to create more shadow, and greenery and evidently to provide cooler areas, thus within the involvement of numerous stakeholders, such as the school, community, and the city of Paris (Caue De Paris; OASIS Schoolyards maintenance guide 2.)

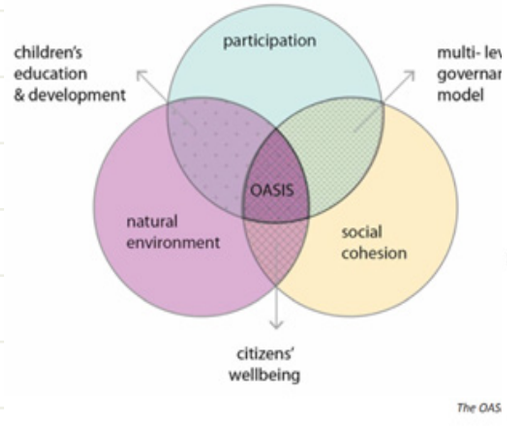


Figure 2 and 3: The OASIS concept and map of 10 schools selected. Source: Les Cours Oasis - Ville de Paris.

MADRID

Healthy school environments / Caring for school environments / School surroundings

3.2 million inhabitants – 505 km²
6.7 million inhabitants – metropolitan area
40.7 highest temperature in June 2019, August 2021, July 2022

•Public funding – municipality budget

•Implementation: 2018 and 2019

•Main target: Heat

•Duration: 1 year

•3 schools 2018 and 2019

•Design criteria: increase shadow; increase soil moist; cycle of water

• Sectorial plans related to climate change
- Guia diseno entornos escolares
- Entornos escolares saludables
- Recovery, Transformation and Resilience Plan Madrid

•Partnerships
- Madrid Health Department ("Madrid, A City That Cares")
- Urban Planning Department ("Plan Madre – Urban Regeneration Strategy")
- Environment Department ("Plan A – Air Quality and Climate Change Plan")

The re-naturalization of the school environment or "Caring for School Environments" project has three main objectives, for instance, climate adaptation, health and social cohesion, and urban regeneration. The project ensures focusing on the surroundings, thus, the immediate or proximate surroundings or the patio itself, throughout different zonings as observed in the image below. Additionally, the design criteria for climate adaptation include increasing shadow, and increase soil moisture and infiltration, in addition to the cycle of water design (De Madrid et al., 2016; Serrano et al., 2017; Vetter, 2020).

Figure 4: School surroundings. (Serrano et al., 2017).

LONDON

Climate resilient schools

8.9 million inhabitants – 1.572 km²
14.8 million inhabitants – metropolitan area
40.2 highest temperature on 19 July 2022

•Public and Private partnership

•Beginning of implementation: 2020

•Main target: Flood, Heat, and droughts

•Up to 100 schools

• Sectorial plans related to climate change

- How London schools and early years setting can adapt to climate change
- Resilience Strategy 2020
- The London Plan

•Partnerships

- London municipality
- Department of education
- Thames Water

London as well has been transforming their schools to adapt to climate change, the city has been using this strategy to cope with its climate impacts, such as heat risk, flood risk, and water scarcity. The document on 'how London schools can adapt to climate change' also provides an understanding of the risks and setting priorities, as well as the measurements that can be used to protect the schools from the climate change, including school ground and building measurements. Therefore, other important topics include responding and recovering from severe weather events, learning and raising awareness, funding, as well as monitoring (Figueiredo et al., 2020; "Climate resilient schools", 2023).

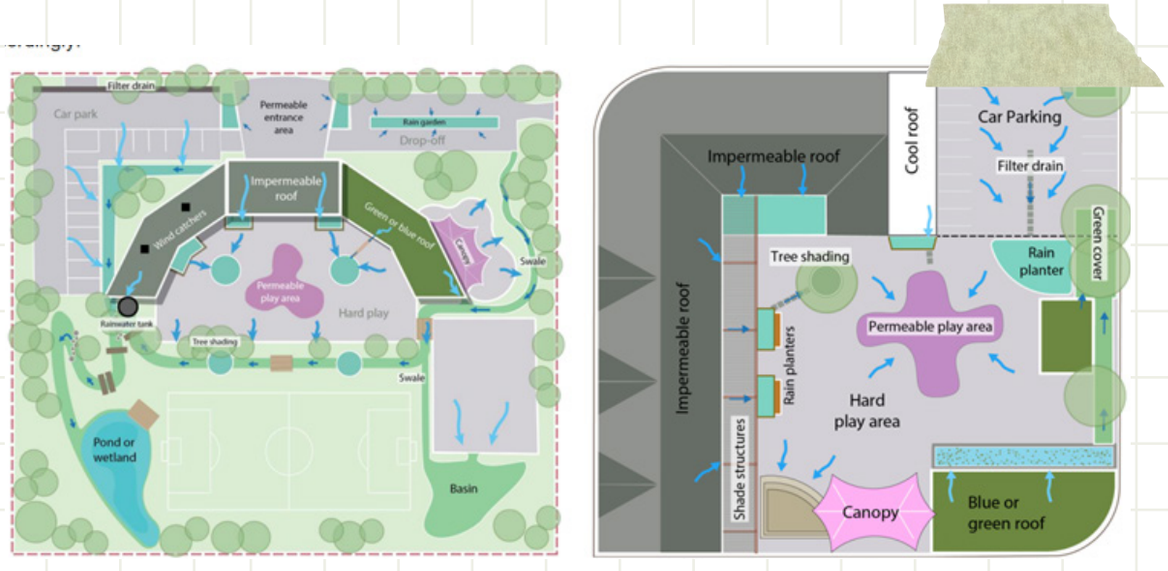


Figure 5: How London schools and early years can adapt to climate change report. Source: Figueiredo et al., 2020.

AMSTERDAM

Greening school playgrounds

36.4 highest temperature July 2019
1.4 million inhabitants – 219,3 km²
2.4 million inhabitants – metropolitan area

•Perfect Interreg Europe

•Beginning of implementation: 2016

•70 schools 2016 to 2018

•15 schools from 2019 until 2024

•Main target: rainwater absorption

•Partners

- NME
- ANMEC
- Amsterdam Impulse Schools (AIS)

• Sectorial plans related to climate change

- Greening school playgrounds in Amsterdam report
- Green Infrastructure Vision 2050
- Strategy for climate adaptation

The city of Amsterdam started the implementation of the project in 2016, although their goals is to increase the number of schools until 2024. Moreover, the goal is to include 25% more of greenery to the schoolyards, stimulating healthier play time. The project included community participation, where it raised awareness for sustainability. The schools selected for the project are open for the public after school hours, as well as on the weekends and holidays, providing therefore an extra public space for the urban area (Antoniadis et al., 2020). The collaboration between public bodies collaborates for a strong team of experts working on the project (Giezen & Pellerey, 2021).

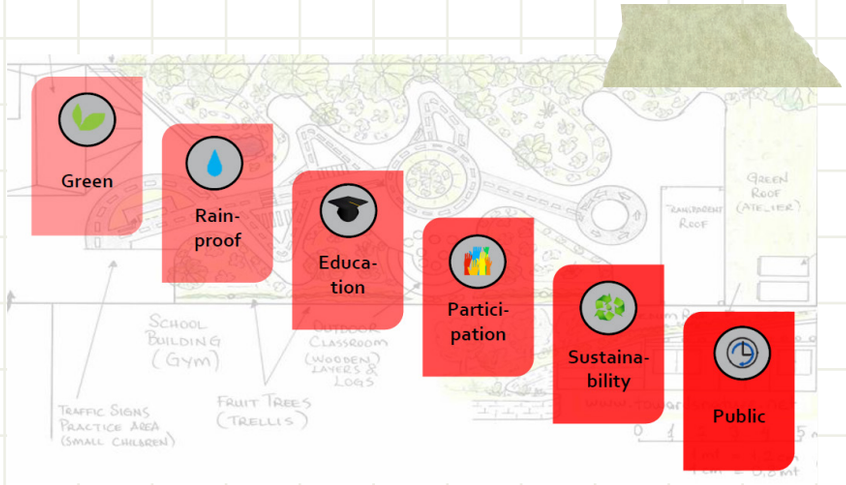


Figure 6: Greening school playgrounds in Amsterdam report. Giezen & Pellerey, 2021.

THE HAGUE

Green School Squares

514 thousand inhabitants – 98.13 km²

•Private initiate – Fonds 1818

•Beginning of implementation: 2011

•187 schools from 2011 to 2016

•Main target: heat and rainwater absorption

•Partnerships
- City of The Hague DSB
- OCW
- HHD
- Fonds 1818
- NME
- DDH

• Sectorial plans related to climate change

- Memorandum on Sustainability: Clean energy in a green city
- Resilience strategy

The city of The Hague has as an aim to provide better and natural environment for children to play, thus through using soft solutions such as changing impermeable pavement to green and sustainable solutions, planting trees, with the goal to increase water absorption and increase in the cooling areas, therefore, adapting the city to climate change (Developing Cooler, Greener Schoolyards across the City | Resilient City Den Haag). The municipality intends on upscaling the projects although since it refers to a private initiative the upscaling becomes more challenging (Giezen & Pellerey, 2021).

Figure 7: School after transformation. Source: Developing Cooler, Greener Schoolyards across the City | Resilient City Den Haag.

BEST PRACTICES

PARIS

SCHOOL OASIS PROJECT

2018 - 2019

Urban Innovation
Actions (UIA)

10

Schools Transformed

2022

75

Schools Transformed

2050

760

Schools to be transformed

Understanding OASIS project

The city of Paris has been facing challenges related to the heat, Météo France one of the partners of the Oasis project has predicted 15 extra days of heat waves, additionally with the raise of the average annual temperature of 1°C to 4°C by the end of the century. Considering that the schools and colleges represent for than 70 hectares of mainly impermeable surface, therefore, maximizing the effects of urban heat island. Moreover, nowadays Paris has a lack of public green spaces, that are accessible to all and can provide cooling effects during summer . Consequently, the transformation of the schoolyard, through the Oasis project provides multiple gains, the addition of greener spaces and water points, the improvement of the well-being of the children as well as other users, the adaptation for the effects of climate change in the next decades (Les Cours Oasis - Ville de Paris). Acknowledging the fact that the residents of the city of Paris have access to public schools within 200 meters from their residential units, the school OASIS aims with the transformation of all the public schools in the city by 2050 (OASIS - School Yards: Openness, Adaptation, Sensitisation, Innovation and Social Ties: Design and Transformation of Local Urban Areas Adapted to Climate Change, Working Jointly with Users | UIA - Urban Innovative Actions). Additionally, the city's current Oasis Schools can be seen on the image aside , and their project for island of refreshment, which includes the Oasis Schools, water feature, swimming pool, libraries, and other facilities.

Detail of schools transformed in 2018 and 2019

1. Jean Dolent. https://sites.google.com/caue75.fr/coursoasisjeandolent/accueil
2. Emeriau. https://sites.google.com/caue75.fr/cours-oasis-emeriau/accueil
3. Tandou. https://sites.google.com/caue75.fr/cours-oasis-tandou/accueil
4. Maryse Hilsz. https://sites.google.com/caue75.fr/coursoasismarysehilsz/accueil
5. Quatre-Fils. https://sites.google.com/caue75.fr/cour-oasis-quatre-fils/accueil
6. Keller. https://sites.google.com/caue75.fr/cours-oasis-keller/accueil
7. Jeanne d'Arc. https://sites.google.com/caue75.fr/coursoasisjeannedarc/accueil
8. Alviset. https://sites.google.com/caue75.fr/cours-oasis-alviset/accueil
9. Greard. https://sites.google.com/caue75.fr/cours-oasis-greard/accueil

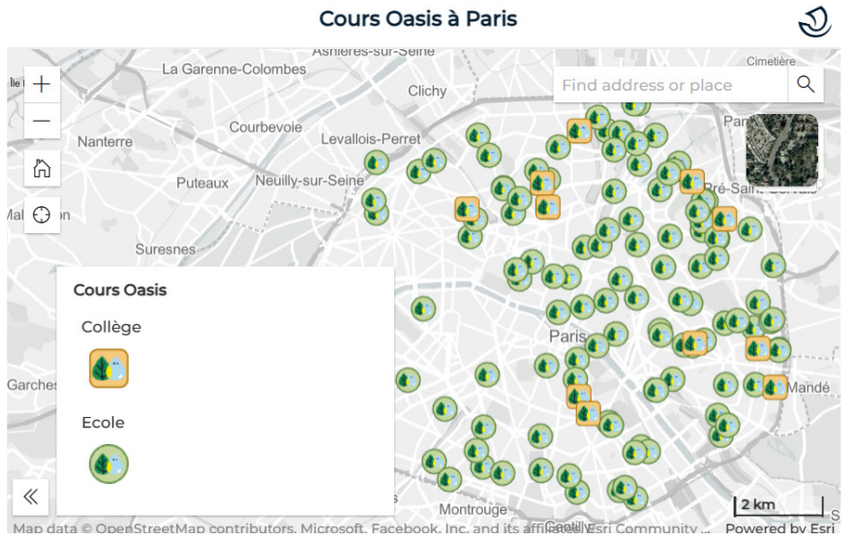


Figure 8: Schools and colleges Oasis project. Source: Les Cours Oasis - Ville de Paris.

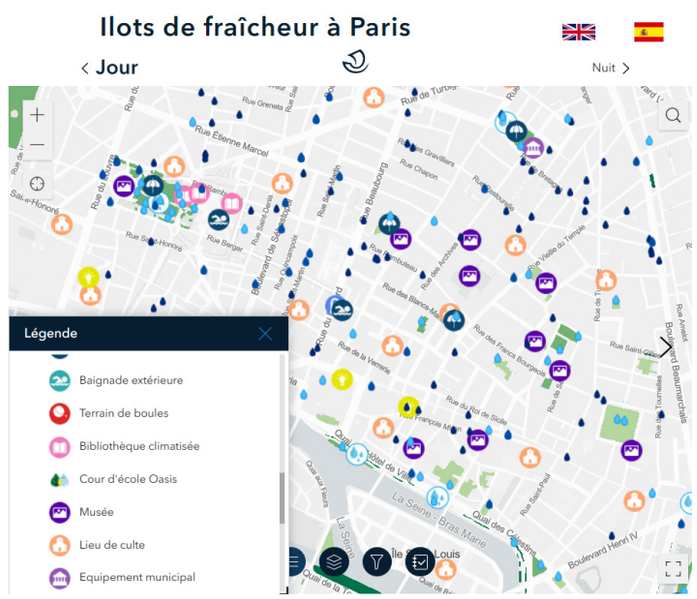


Figure 9: Islands of freshness in Paris from the Heat wave plan . Source: Canicule : Toutes Les Infos - Ville de Paris.

THE SCHOOL OASIS METHOD

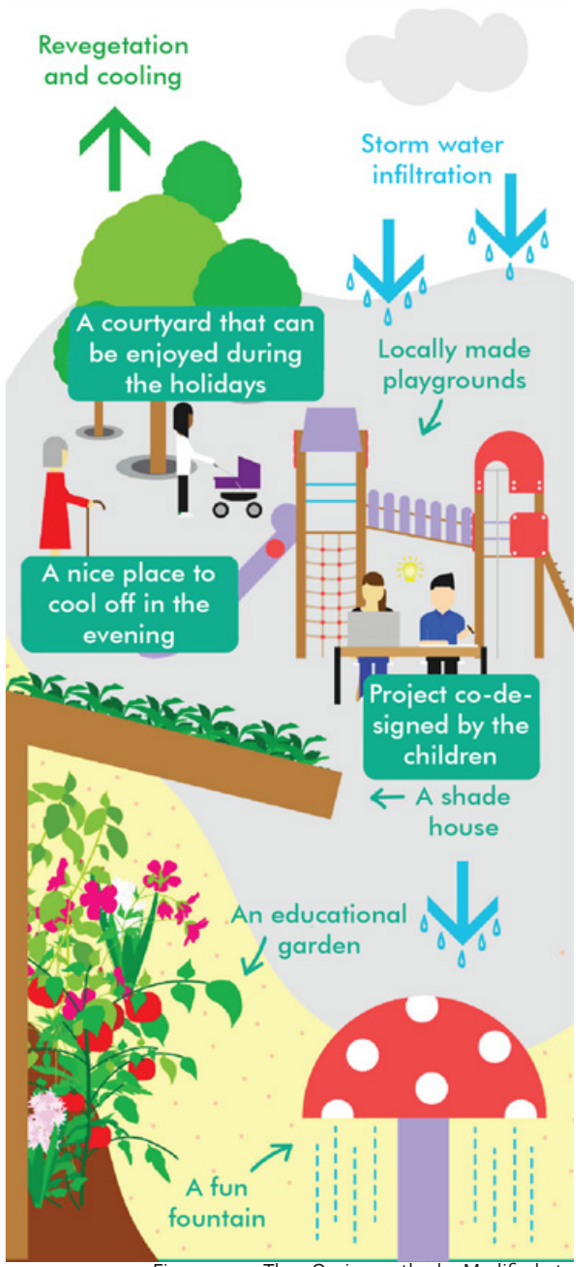


Figure 10: The Oasis method. Modified to English. Source: Les Cours Oasis - Ville de Paris.

The implementation of the School Oasis according to the city of Paris

Les Cours Oasis - Ville de Paris

- **The floor is given special attention:** prioritizing the use of natural materials, that avoid storing heat and that work better for the management of rainwater. Provide a balance in between permeable and impermeable areas. Additionally, preserving floors that still in good condition if coordinated with goals are an option.

- **The vegetated surfaces are increased:** Giving priority to plants that are more resistant to effects of climate change, as well that adapt better to the environment of the school area. Not simply the plantation of trees, but encouraging all types of greenery.

- **The furniture seeks to meet the needs:** Prioritizing the choice of the furniture that provide various outdoor activities, such as climbing, steps and sensory trails. Opting for recycling and short circuit materials.

- **Shade and water:** Increasing the amount of shaded areas as well as the water points, use of the water for urban refreshments, in addition to the installation of water fountains.

- **Participatory dimension:** The goal is distribute the tasks and to involve adults and children, thus promotes also the appropriation of the area by citizens.

The stages of the School Oasis

Les Cours Oasis - Ville de Paris

1.Co-design:

Workshops promoted by CAUE 75, including the children and the school community, with the objective of increasing the awareness about the objectives of the project, thus adaptation to

2. Transformation of courtyards:

Starting in summer of 2020, transforming the courtyards by de-paving and providing permeable materials and solutions, increasing of greenery and water points.

3. Participatory projects:

Delegating to local community, parents, professors and volunteers the activities of carpentry, cutting, and painting.

4. Opening to the public:

The opeing of the schoolyard started on summer of 2022, by mobilizing local community.

5. Collection of data:

Provided my Sciences Po and ESIEE Paris/LIED as well as Météo-France, to contribute with the understanding of the impacts. In addition to providing a climate diagnosis of before and after to understand the reduction of urban heat island.

School Qualitative Analysis

The development of the analysis above was done by image observation, therefore understanding the information available online referent the school's transformation development and implementation. Moreover, the analysis was carried through two aims, practical and design, thus, to understand the process of transformation, observing images from before, analysis stage, project development, and images after. Nevertheless, the information carried above refers to the availability of material, concluding that simply because the information does not exist does not imply that the steps were missing, for instance, thermal and building mass analyses were probably carried out for more schools, although the information has not been released on the websites related to the project.

School Analysis
"OASIS" Project

Table 1: School Analysis "OASIS" Project. Author's elaboration.

1. Ecole Maternelle Jean Dolent

Within the analysis of the Oasis project schools two of them have presented a better result for the practcal analysis. Therefore in the following the steps for the transformation of the school yard developed by Ecole Maternelle Jean Dolent. Moreover, it is important to observe the original context, the analysis developed, the participation process and the final project with the selection of materials.

Before transformation:

Figure 11. Schoolyard before transformation. Source: Cours Oasis Jean Dolent.

Thermal Analysis:

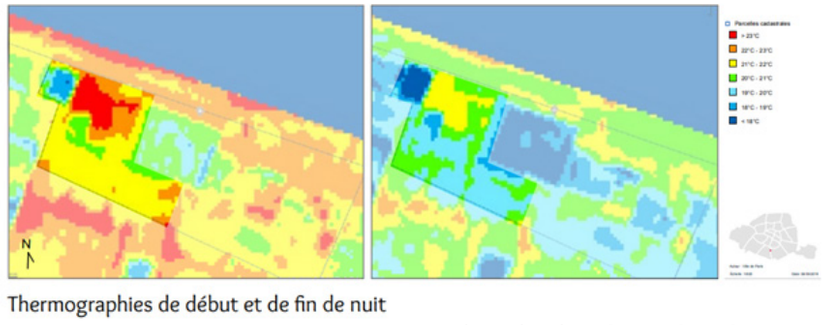


Figure 12. Thermal analysis. Source: Cours Oasis Jean Dolent.

Model of the project created by the students:

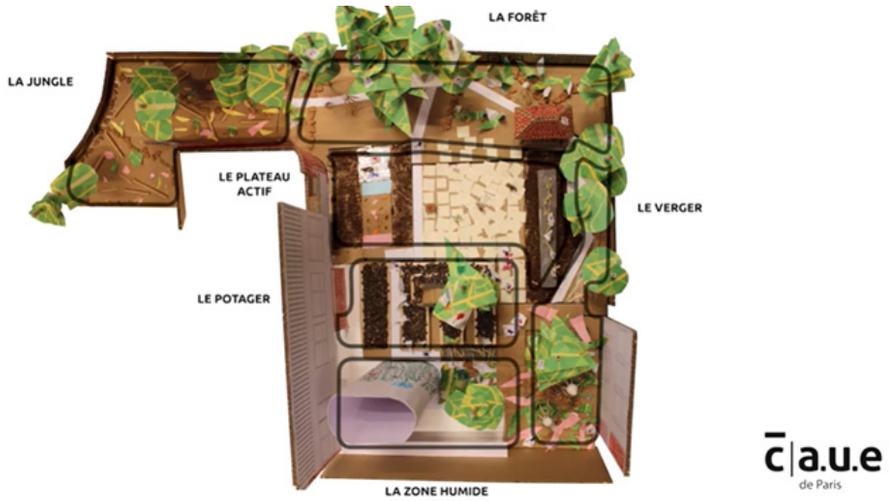


Figure 13. Model of the project created by students. Source: École Maternelle Jean Dolent.

Project and materials selection:

Figure 14. Project and material selection. Source: École Maternelle Jean Dolent.

2. Ecole Elémentaire Jeanne D'arc

Secondly the process developed by the elementary school Jeanne D'arc. Importantly addressing the changes from before and after transformation, stressing the change on the paving, the increase of greenery, the usage of nature based elements for the play time for the children.

Before transformation:

Figure 15. Before transformation. Source: École Élémentaire Jeanne D'arc.

Thermal Analysis:

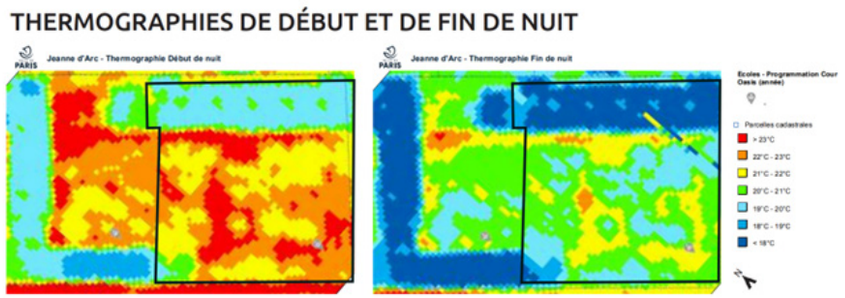


Figure 16. Thermal analysis. Source: co-conception projet de transformation de l'école élementaire Jeanne D'arc.

Project:

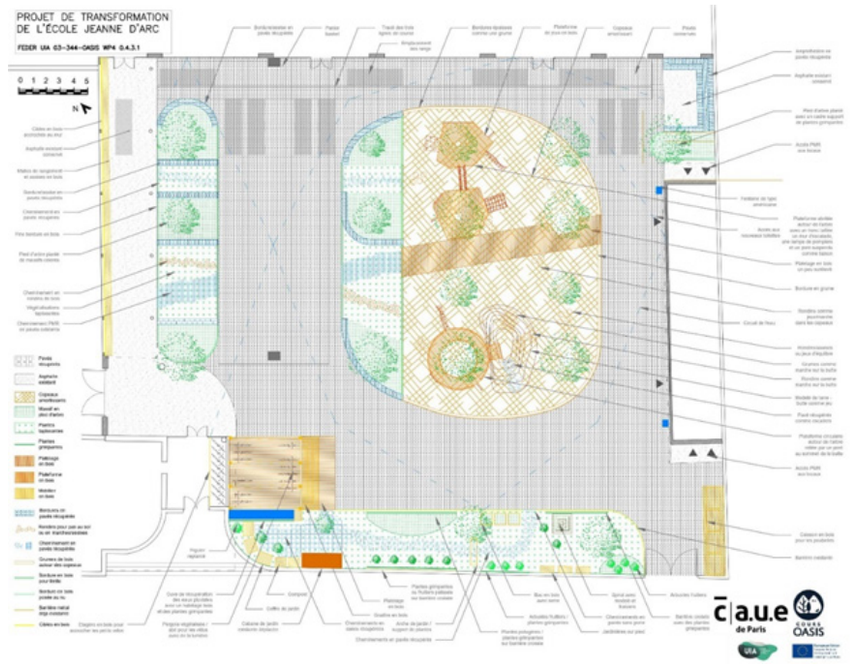


Figure 17. Schoolyard Project. Source: Cours Oasis Jeanne d'Arc.

After:

Avant : vue depuis le portail

Après : aménagements naturels et sols perméables dans la zone de sous-bois

Figure 18. After transformation. Source: Cours Oasis Jeanne d'Arc.

DESIGN ELEMENTS PARIS

SHADING ELEMENTS

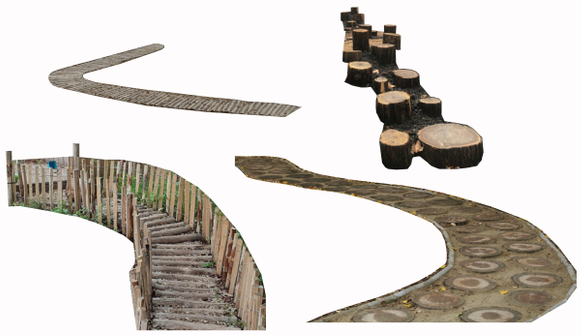
ADDITIONAL ELEMENTS

TREES

WATER FOUNTAINS

WATER MANAGEMENT

NATURAL PAVING



GARDEN

BEST PRACTICES

BARCELONA

Climate Shelter Project

2018 - 2019

Urban Innovation
Actions (UIA)

11

Schools
Transformed

Lets Transform Schoolyards Project

2020 - 2021

10

Schools
Transformed

10 new schools per year

CLIMATE SHELTER PROJECT

4500 kids benefited in the school

1350 kids benefited in summer camps

3000 m2 of schoolyard transformed

4500 m2 of urban green areas added

2213 m2 of shaded area

1000 m2 from concrete to vegetation

74 new trees

26 new fountains

Background

As many other cities around the world, Barcelona has also predictions for the increase of the temperature in the next decades, by 2050 the temperature in the city is supposed to rise from 2.8 °C to 3.2 °C. Additionally, an increase 20 days a year over 30 °C is predicted, therefore exposing the population to potential severe health issues (Science in the City). Moreover, the city of Barcelona has also developed a neighborhood heat analysis, understanding that different areas in the same city have different vulnerabilities for the heat. From the analysis it was possible to understand that certain neighborhood where more exposed to the heat, for example coastal neighborhoods presented to have the lowest temperatures during the day, whereas, presenting the highest temperatures during the night (Barcelona's Pilot Project to Beat the Heat).

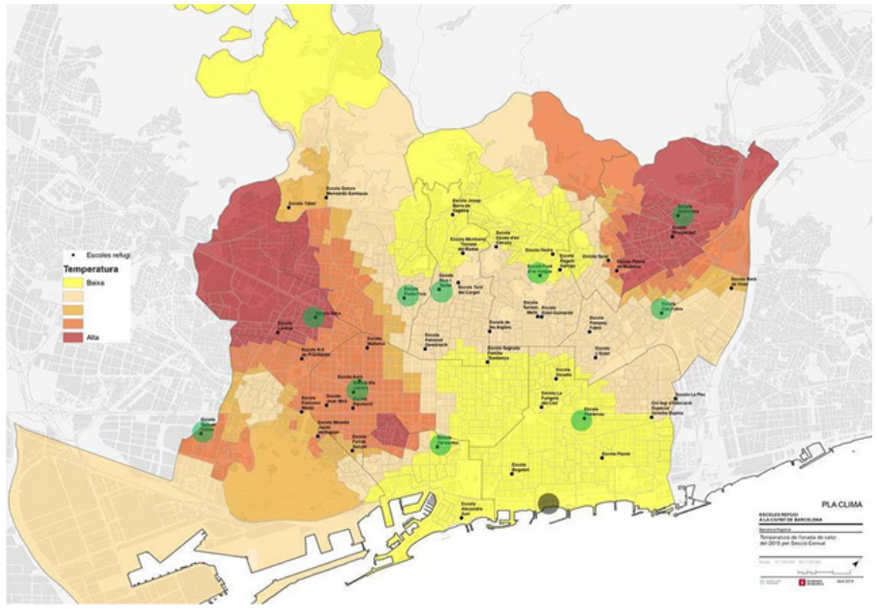


Figure 19. Air temperature differences from average for Barcelona. Source: Barcelona's Pilot Project to Beat the Heat.

METHODOLOGY

The Climate Shelter project in Barcelona has the aim of coping to the addressed challenges related to heat. Moreover, to bring into live the initiative the city was supported by the Urban Innovation Actions on the transformation of 11 different schools from the period of 2019 to 2022, each school located in a different district as shown on the image above. The project also coordinates with the strategic adaptation to climate change by the city of Barcelona, therefore, the initiative has aim to cope with the achievement of the Barcelona 2030 Agenda, SDG targets and key indicators (Cultivating a School Culture for Climate Action - The Barcelona Example; Indicators as Tools for Adaptation to Climate Change at the City Scale - The Climate Shelters Project of the City of Barcelona).

- By 2030, Barcelona will achieve, with social consensus, a change of urban model in order to attain healthier and more sustainable public spaces, especially in areas surrounding schools.
- By 2030, Barcelona will comply with the air quality thresholds recommended by the World Health Organization
- By 2030, 100% of the population will be less than 300 meters from climate shelter
- By 2030, nearly 30% of Barcelona will be covered by trees
- In the decade 2020-2030, Barcelona will have effective tools for improving education, awareness-raising and human and institutional capacity for the mitigation adaptation, impact reduction and early warning of climate change

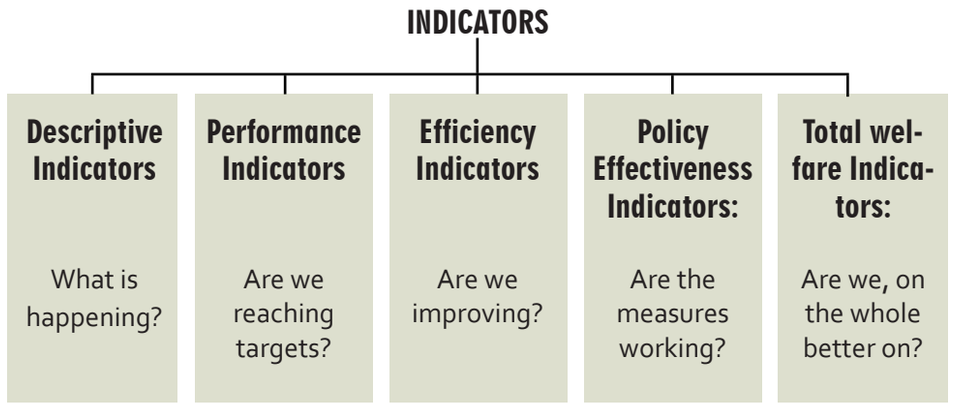
> (Indicators as Tools for Adaptation to Climate Change at the City Scale - The Climate Shelters Project of the City of Barcelona). Modified by author.

> (Cultivating a School Culture for Climate Action - The Barcelona Example). Modified by author.

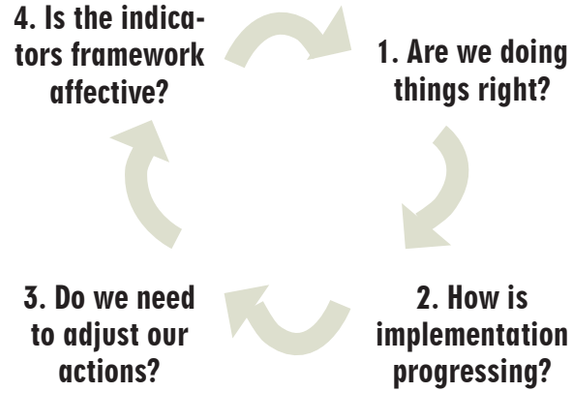
Moreover, the city of Barcelona entities that the climate change project has not only the aim to adapt the city for the climate change, however, to also provide awareness, not only students and teachers, but the whole community and stakeholder involved. For instance, this approach provides a successful implementation to the project, where it motivates people to be part of the change. The project contains three educational aims, firstly, to promote a network that acknowledges climate change and how to adapt to it. Secondly, the incentive on understanding strong links on the natural, social, and built environment. Thirdly, providing the vision related to community participation on the strategies addressing the challenges related to climate change in the urban scale (Cultivating a School Culture for Climate Action - The Barcelona Example).

INDICATORS

Importantly, to monitor the progress of the climate shelter project the city of Barcelona used a category of indicators, following the indicators by the European Environment Agency. The indicators tool are key elements for the understanding of the impacts relates to social, climatic, and environmental issues. The same provide a possibility on the detection of problems and lacking areas towards to the achievement of the targets of the climate shelter project. The indicators are divided into different categories each related to a different target, as demonstrated bellow: (Indicators as Tools for Adaptation to Climate Change at the City Scale - The Climate Shelters Project of the City of Barcelona).

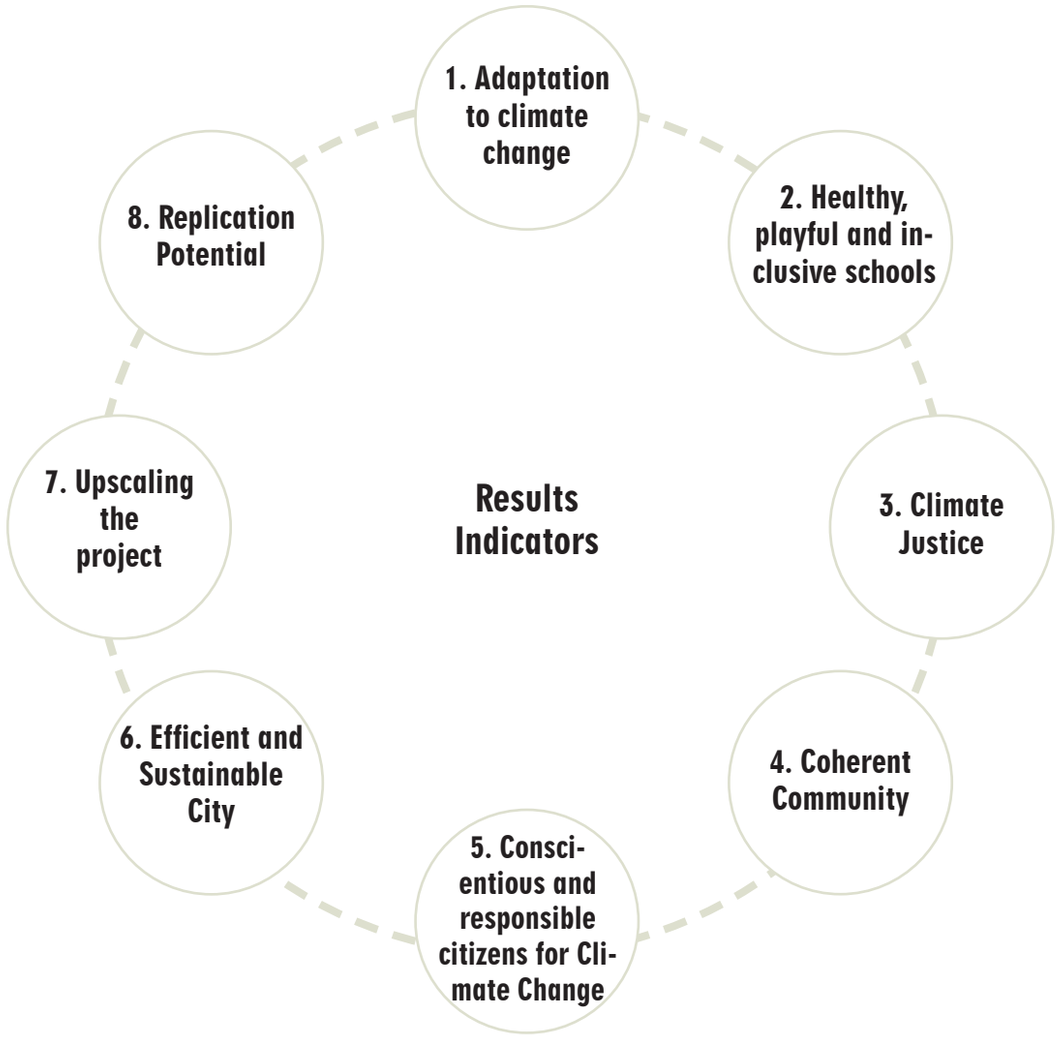


> (Indicators as Tools for Adaptation to Climate Change at the City Scale - The Climate Shelters Project of the City of Barcelona). Modified by author. Categories of indicators by the European Environment Agency



> (Indicators as Tools for Adaptation to Climate Change at the City Scale - The Climate Shelters Project of the City of Barcelona).

Furthermore, eight different performance sets were developed for the extracting of the results of indicators. To better explain, the indicators are divided into quantitative and qualitative approaches, moreover, addressing three main questions related to measurements, understanding what, how and how often is measured.



> (Indicators as Tools for Adaptation to Climate Change at the City Scale - The Climate Shelters Project of the City of Barcelona). Modified by author. The sets of Indicators of the Climate Shelters project.

Criterion

Importantly, in order to select the eleven schools for the climate shelter project, the commission created different criteria, divided into compulsory, priority and tie-breaking criteria (Project Refugis Climàtics). The criteria are the following:

Compulsory criteria

- **Universe:** determining the school universe

Priority criteria

- **Impact:** understanding the impact on the people involved in the school, such as students, teachers, and community.
- **Around:** Evaluation of the school environment conditions
- **Building:** Infrastructure, thermal and energy efficiency evaluation
- **Yard:** Evaluation of yard conditions, paving, sunlight and water availability

Tie-breaking criteria

- **Complexity:** Analysis of students' social vulnerability

Design Strategies

Subsequently, the strategies used in the climate shelter program promotes three types of interventions, thus, green, blue, and gray infrastructure. Firstly, green interventions, promoting a caution on the selection of plant types, in addition to station the location of vegetation implementation, such as ground, and building facade, wall and roof. Secondly, blue interventions are not limited to providing access to drinkable water but as well to use blue elements as multi-functional approach providing cooling effects, collecting water and promoting playful activities. Third, grey solutions are related to the architectural and technical elements, thus promoting the use of renewable energy, insulation and shading solutions (Project Refugis Climàtics).

According to the city of Barcelona there are three ideas to consider when talking about climate shelter. To begin with, climate responsive urban design is vital to urban sustainability, therefore meaning that choices such as pavement, building materials, and vegetation provides difference for air pollution, thermal comfort, encouraging outdoor activities. Secondly, is that one solution does not fit all, does speaking about city context where different parts of a same city might need a different solution, in addition to emphasizing the importance of individual building analysis. Lastly, urban design needs to be participatory, encouraging bottom-up approaches, and involving different stakeholders, not limiting to the ones with knowledge in the field, stimulating citizens participation (Science in the City).

Furthermore, understanding that each school should be analyzed as a single transformation, therefore understanding its solar and windy condition, the climate shelter project provided a set of standardized guidelines to be considered: (Science in the City)

- **Balance between paved and green spaces and the effects on the thermal environment:** analyzing the greenery in the area under study, considering that school patterns in urban area are highly concentrated by impermeable paving and lack of greenery.

- **Building orientation:** might be used as a guide for achieving the desirable micro-climatic in the school environment.

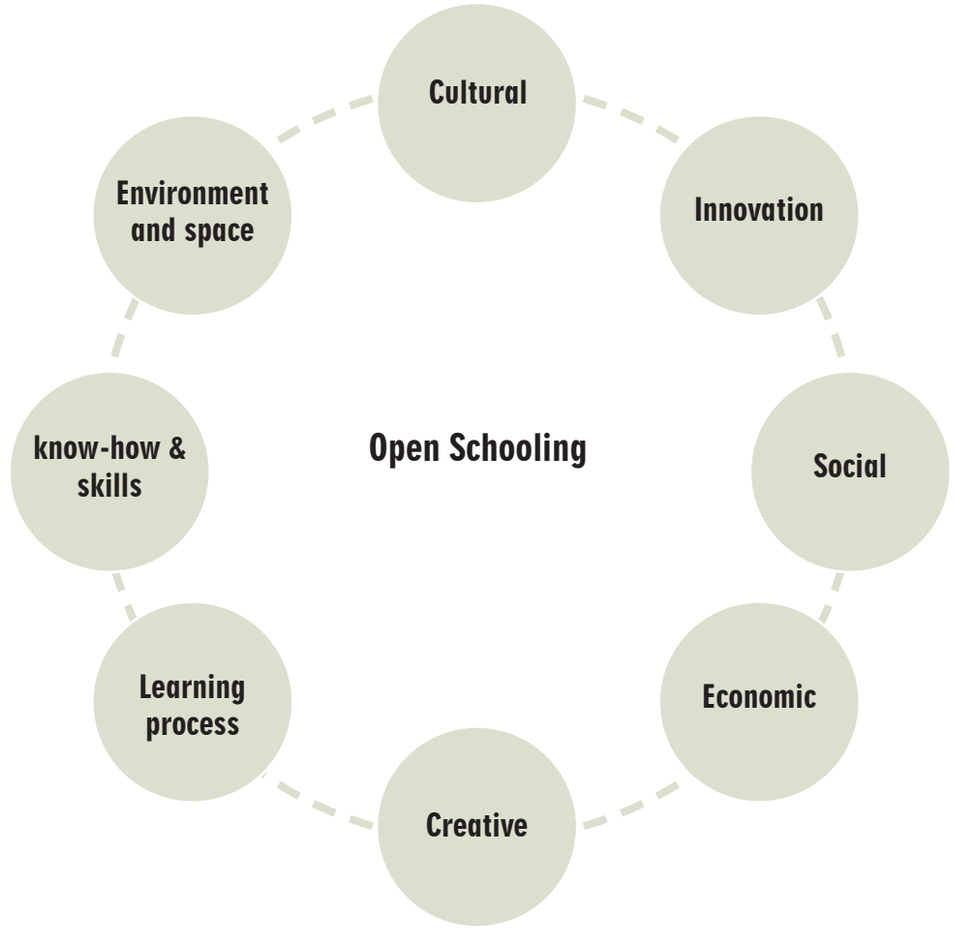
- **Change of material to the improvement of thermal environment:** emphasizing that material have high influence on absorption of the heat, therefore color and texture should be considered.

- **Ventilation and airflow:** to cope with the reduction of urban heat island blue and green infrastructures provide a cooler air flow.

- **Vegetation influence:** when considering urban areas, vegetation plays a big role in reducing heat, urban vegetation can cool air up to 3.3°C.

Open schooling concept

Moreover, climate shelter project incentives the open schooling concept, where it claims to provide several benefits, such as increasing the livability of the neighborhood and school area, in addition to enhancing the discovery and participation of the community collaborating for the reduction of social disparities (web 74). Therefore, it encourages the decision-making of the community on the development process, providing interaction in between social and technical knowledge, such as with parents and architects involved in the development, forming a constructive deliberation (Cultivating a School Culture for Climate Action - The Barcelona Example). Importantly, the replicability of the climate shelter is another goal for the city, both when addressing open schooling and social participation and involvement, as well as the urban design process when developing a new climate shelter, therefore, providing a platform of interaction as well as coping to adapt cities to climate change (Science in the City). As addressed on the Barcelona Climate Plan the goal is to provide 5 minutes walk-ability to a climate shelter, therefore providing thermal comfort especially for vulnerable groups of people during heat waves (Barcelona's Climate Action Plan 2018 - 2030, 2018).



> (Science in the City). Modified by author. The open schooling concept as applied in the Climate Shelters project

Upscaling Process

As a goal on upscaling the city of Barcelona developed the project called "Let's transform the school yards", this project had the aim of continuing the transformation on schoolyard as the climate shelter project. The goal of the project is to transform a minimum of 10 schoolyards per year, therefore collaborating for the increasing in green areas in the city. Moreover, considering that the schoolyard is part of the pedagogical environment of the school, the vision of the project still to provide awareness and knowledge related to climate change and adaptation to climate change in urban areas to students, parents, teachers, and the whole community. In the "Let's transform the school yards" project, the physical changes continue to follow the premises of the climate shelter standards. Moreover, the project contains four guidelines, for instance, increase the greenery and natural areas, increase shaded area with the use of natural based solutions or different structures such as wooden, increase the permeable paving providing coherence with educational activities, and lastly, provide natural elements that increase playing activities such as water and shading elements (Upscaling with a Vision - The School Yard as a School).

Additionally, a set of criteria were developed in order to ensure the coherence with the philosophy of the climate shelter project, represented in the following:

- **Does the upscaling process sustain the main philosophy of the project >** Enhancing the educational goal of awareness to students, parents and teachers as developed in the climate shelter project.

- **What should be the next step of a project: gradual or a generalized upscaling >** Providing a gradual upscaling of 10 schools transformation per year.

- **What evaluation criteria should be used to assess an upscaling plan >** The criteria relates to the selection of the new schools for the upscaling process. For the project there are six different criteria for the selection, in the following: Environment, socio-economic complexity, school yard infrastructure, uses and dynamics in the schoolyards, and motivation.

- **Can the project have a greater impact on the long term >** referring to the impact that goes beyond physical environment, but upscaling the knowledge on the school environment.

- **When should the upscaling process start >** Ensuring that upscaling should occur when evaluation phase is fully completed.

- **What are the additional or new challenges of deploying the project at a larger scale >** in Barcelona case the personnel of the Education Council were considered a necessity in order to achieve the goals and aims of the project.

- **What should be the role of the partners be in the upscaling process >** The coordination of tasks for different partnerships are considered an important criterion to avoid overlaps, therefore, for the city of Barcelona daily coordination is provided by Barcelona Educational Council and the open debates are a task of the teachers association.

Schoolyard qualitative analysis

"Climate Shelter" project

"Let's transform schoolyard" project

The development of the analysis bellow above was done by image observation, therefore understanding the information available on-line referent the school's transformation development and implementation. Moreover, the analysis was carried through two aims, practical and design, thus, to understand the process of transformation, observing images from before, analysis stage, project development, and images after. Nevertheless, the information carried above refers to the availability of material, concluding that simply because the information does not exist does not imply that the steps were missing, for instance, thermal and building mass analyses were probably carried out for more schools, although the information has not been released on the websites related to the project.

School Analysis
"Climate Shelter" Project

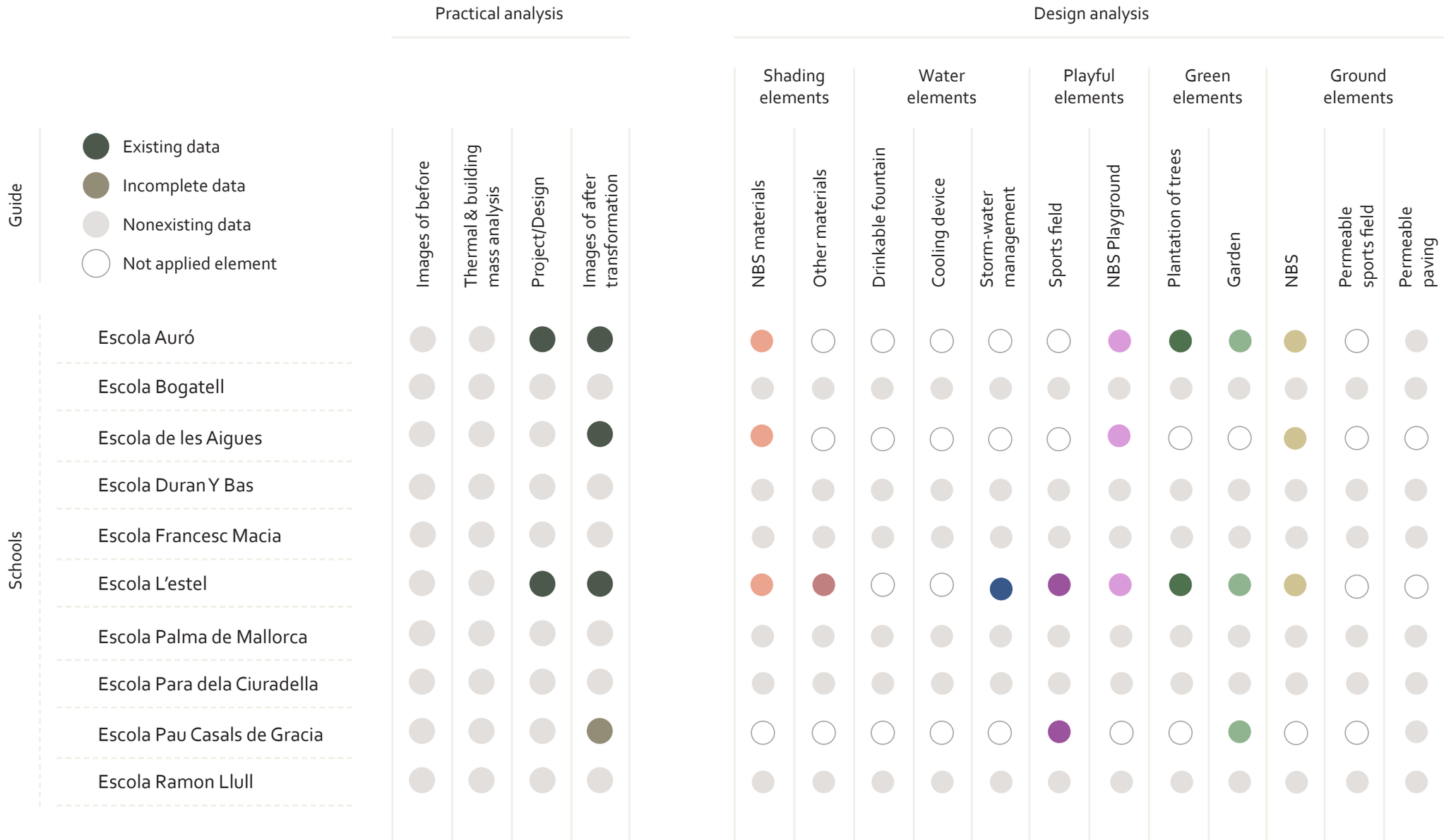


Table 2: School Analysis "Climate Shelter" Project. Author's elaboration.

School Analysis
"Lets transform schoolyards" project

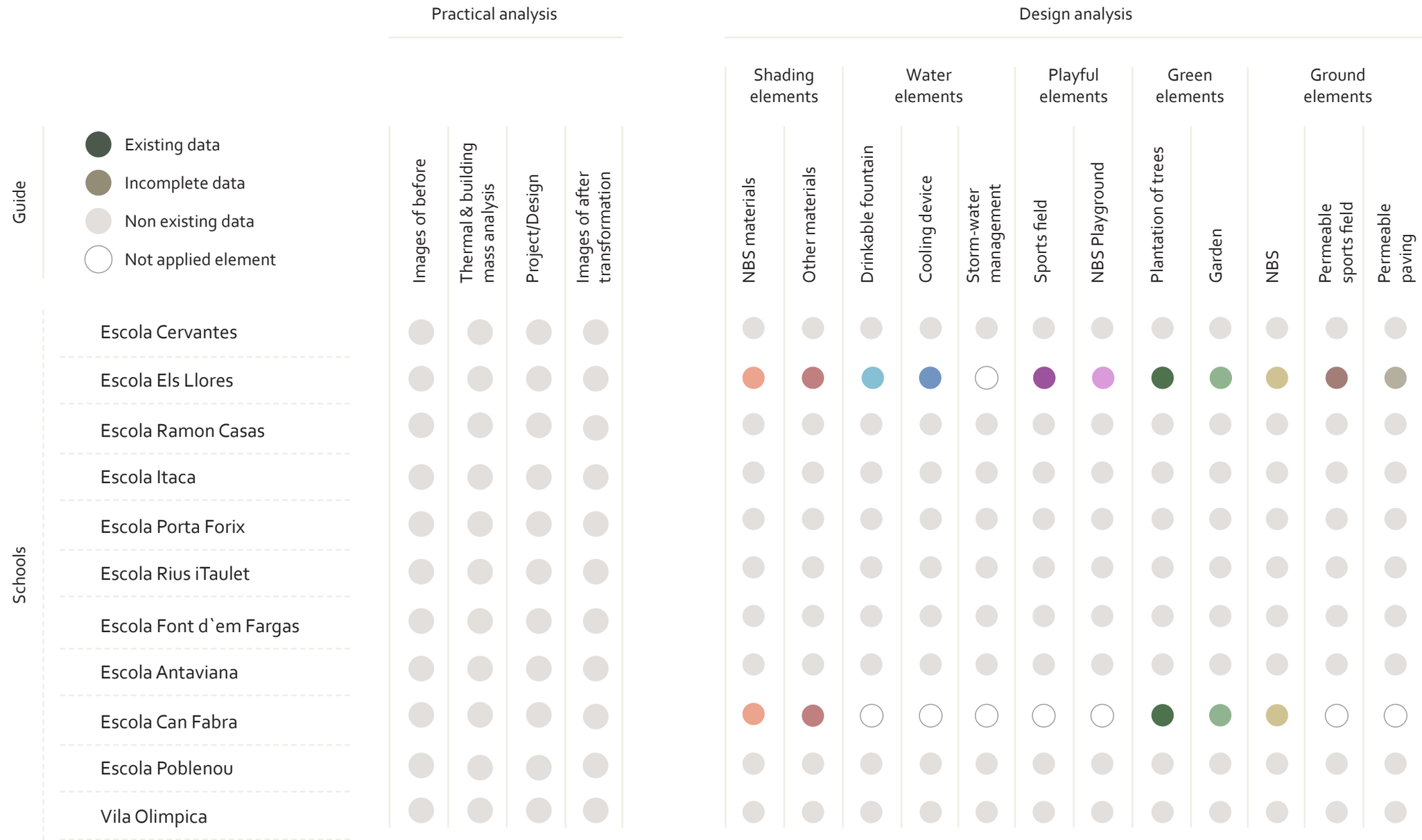


Table 3: School Analysis "Lets transform schoolyards" project. Author's elaboration

Escola Els Llorers

1. Building orientation > To begin with the analysis started by the understanding of the building volume and orientation in relation to the urban scale, where it was described as "trapped" in between dense building blocks. Sun and ventilation analysis were also part of the processes where from the images is possible to understand the limitation of the ventilation, therefore the higher exposition to solar radiation.

Figure 20. The Els Llorels school (bottom left) and its position in the local urban environment. Source: Science in the City.

Figure 21: The Els Llorers school from a different view and a view of the green part of its yard. Source: Science in the City.

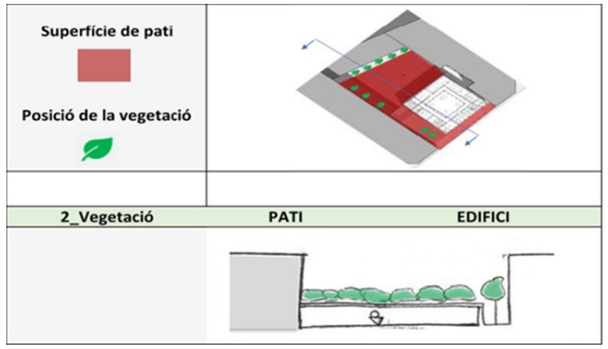


Figure 22. Plan view of the school's yard and its greenery. Source: Science in the City.

2. Greenery and paving balance> the analysis resulted in an understanding of the lack of greenery, represented by 20% of the schoolyard, therefore a schoolyard that does not differ from the traditional paved and impermeable material.

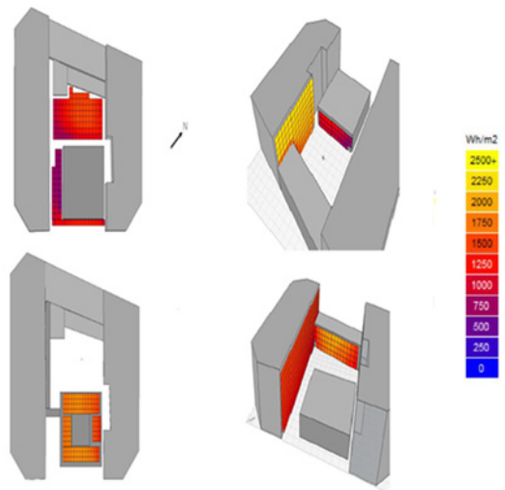


Figure 23. Amount of Watt hours (Wh) per m2 at the school yard as well as the side walls of the school at different orientations to the horizon. Source: Science in the City.

3. Building volume and orientation to achieve micro-climate desirable conditions > Moreover the previous step was used in order to estimate the amount of Watt hour (Wh) per m2 for the walls as well as the schoolyard, therefore, yellow and red color representing the excessive exposure to solar radiation, thus, resulting in thermal discomfort on the outside and inside of the school.

4. Ventilation and airflow > To provide suitable solutions the analysis of the ventilation and airflow provide influence in the solution, therefore, in this case the analysis results determining the facade with higher wind pressure and the facade with higher exposure to solar radiation.

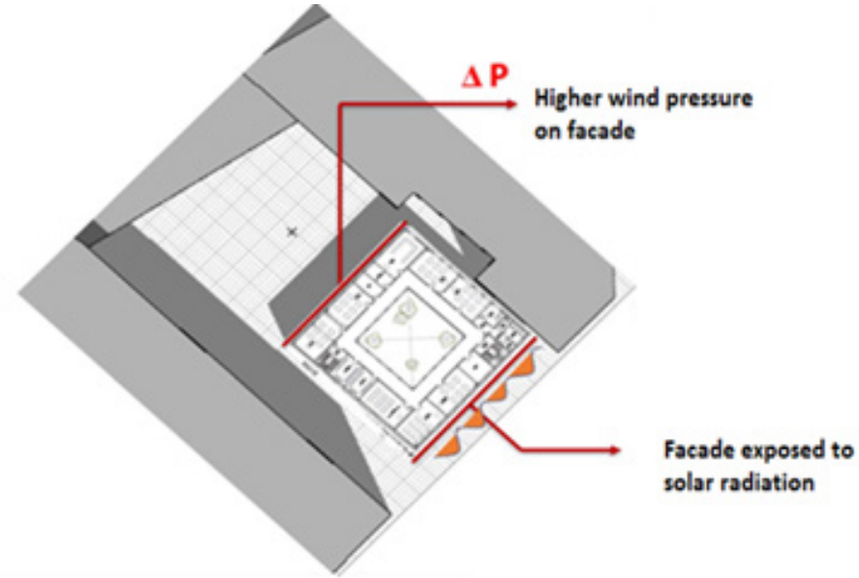


Figure 24. Depiction of the school areas exposed to wind and solar radiation. Source: Science in the City.

5. Participation process > to bring science to the local community one important step for the implementation of the climate shelter is the involvement of different stakeholders, therefore in the case of Els Llored schools the participation of parents, students and teachers were essential for the development of a survey, where it identify in different categories the priorities of elements to be implemented in the schoolyard. 258 people participate on the survey, 153 students, 90 parents, and 15 teachers. The results of the survey show results such as students prioritized more fountains and shaded areas, where parents prioritized more shaded areas and trees.

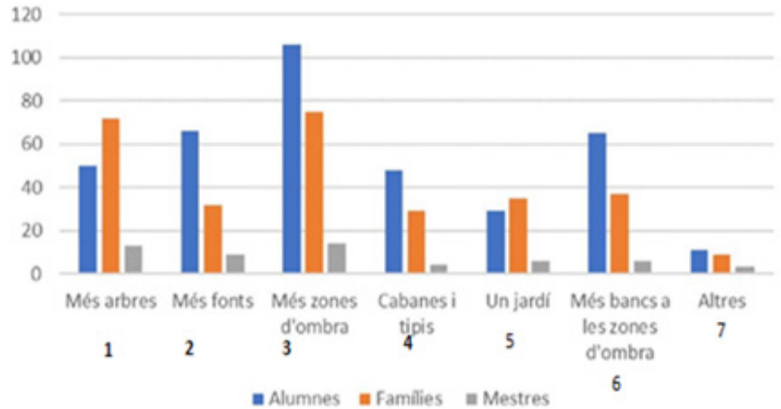


Figure 25. Preferences from students, parents and teachers for solutions to be applied at the school yard. 1: more trees; 2: more fountains; 3: more shaded areas; 4: tents; 5: a garden; 6: benches at shaded areas 7: other (y-axis: number of respondents). Source: Science in the City.

Figure 26. Furthermore, potential solutions for the conversion of the school to a Climate Shelter were examined through a wide and intensive participatory process, involving teachers, students and parents. Source: Science in the City.

6. Design > Finally, the results of the design represent an understanding of the analysis process, acknowledging the survey realized with students, parents and teachers.

Figure 27. Project design. Source: Science in the City.

After transformation >

Figure 28. After transformation. Source: Science in the City.

DESIGN ELEMENTS BARCELONA

SHADING ELEMENTS

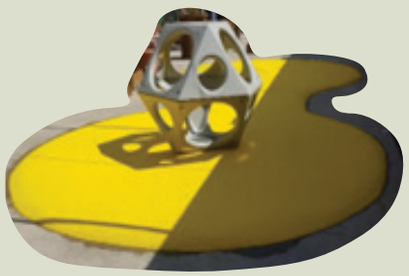
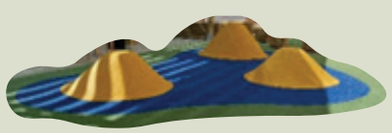






WATER FOUNTAIN

PLAYFUL ELEMENTS

VEGETATION









7 DESIGN ELEMENTS identified in case studies

SHADING ELEMENTS

NBS PATH

WATER MANAGEMENT

FOUNTAIN

TREES

GARDEN

NATURAL PAVING

Sand

Hay

Wood

Wood
Gravel

Gravel

Grass

BEST PRACTICES COMPARISON

	BARCELONA	PARIS
Guidelines Process	Very Strong	Moderate
Participatory Process	Very Strong	Moderate
Children awareness	Strong	Very Strong
Design project	Weak	Strong
Solar/landscape analysis	Moderate	Strong

BARCELONA

Climate shelter is comprehensive and exemplary project, above all the guidelines provided by the city are impeccable with information and explanation, for each step of the process there are steps that should be followed. Nevertheless, an excessive amount of content can also be confusing, especially on the case of Barcelona where the data is available in many different web pages, therefore, a main document with all the content would be the best solution. Likewise, the participatory process and the involvement of the community provide further level of detail, making it possible to observe the interaction between parents and teachers. Lastly, the design of the project represents a lack of details and depth of information, whereas, providing a superficial explanation on the elements of transformations, such as no further information on use of materials. Notably, this may be cause by the absence of information and images documenting each school's transformation.

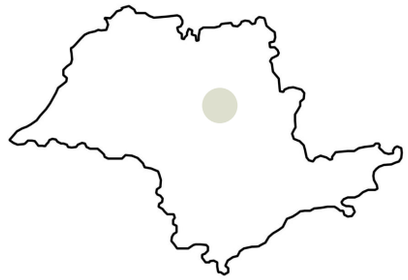
PARIS

Overall school Oasis project is explained in a concise matter, one of the biggest strengths is the clarity on the process of transformation of the schoolyards, for each school it is possible to find a separate website from Conseil d'architecture de'urbanisme et de l'environnement (ca.u.e de Paris) with images of the construction site, as well as videos explaining the process for the development of the design. The images shown the interactive process where the kids, parents and professors were part of it, on planning trees, on the observation of installation of elements, as well as the process of awareness of the children about climate change. Fore and foremost, Oasis project focus mainly on the development of the design and layout of the schoolyard, exhibiting the landscape, thermal and windy analysis for all the schools. However, a weakness is the overall explanation about the project development process, such deepening in the guidelines, choice of spaces to be transformed and criteria.

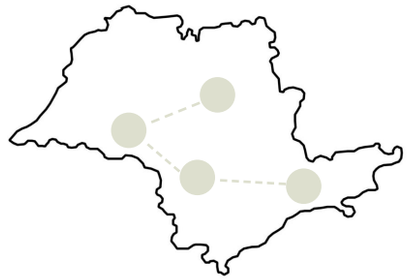
CHAPTER 04.

UCS GUIDELINES

The purpose of the guidelines chapter is to introduce the concept of Urban Climate Shelter in a comprehensive and mainstream matter. The concept aims that improvements can start moderately by installing a single UCS on an uncomplicated and reachable goal, nevertheless, the objective is to scale the same up in order to succeed in the long run. In addition, the conceptualization of an Urban Climate Shelter can be observed on the next page and, it starts with a subject that needs to be transformed, such as an urban area or city. As a second phase, climate hazards in this urban region need to be recognized through a context analysis. These hazards may include urban heat islands, flooding, cyclones, etc. In addition, each climate hazard is followed by a goal to mitigate the problem. The fourth phase entails understanding the plans and policies currently available in the urban area and determining whether they are sufficiently tackling the problems or if a new plan is needed. Finally, the last step is the installation of the Urban Climate Shelter, which aims to address hazards holistically by involving the community, raising awareness of climate challenges, and adopting a multi-hazard strategy.



SINGLE UCS

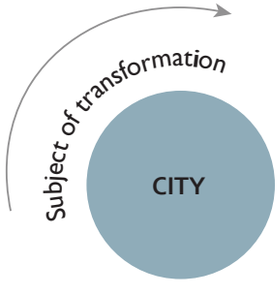


NETWORK UCS

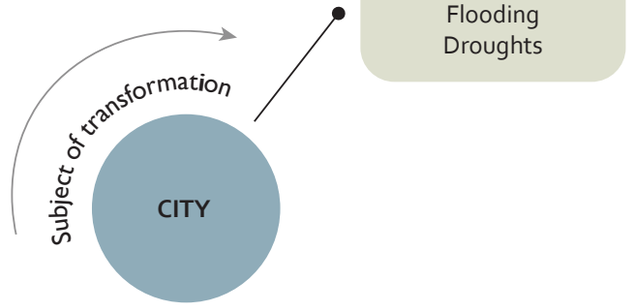
SHELTER CITY

CONCEPT illustration

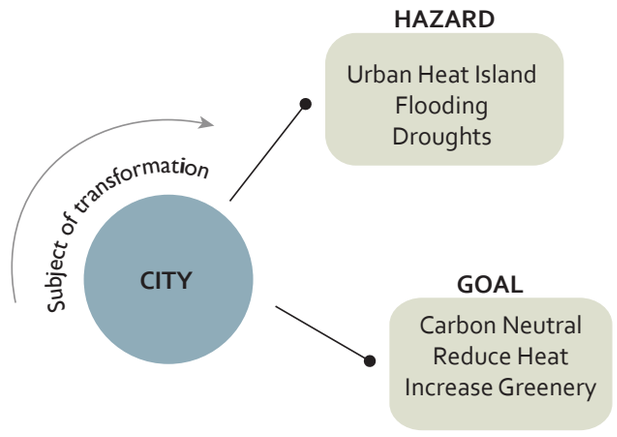
1



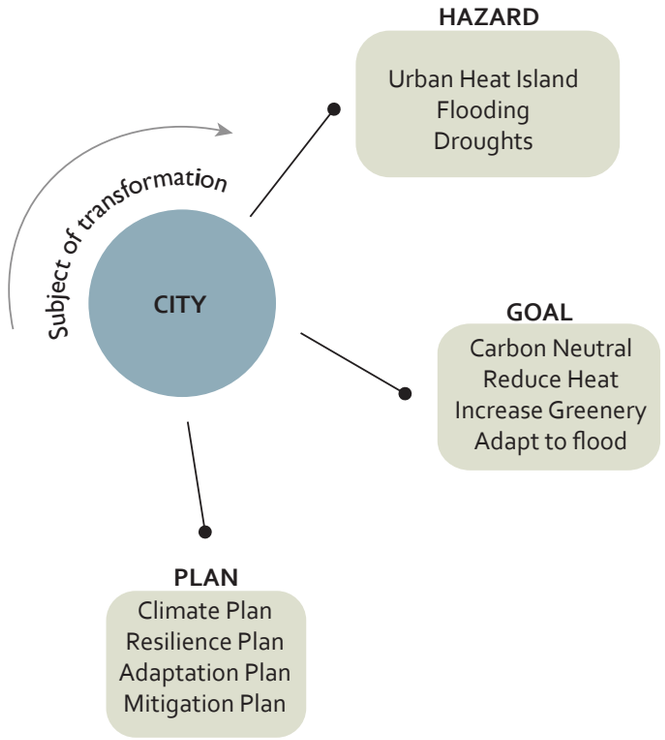
2



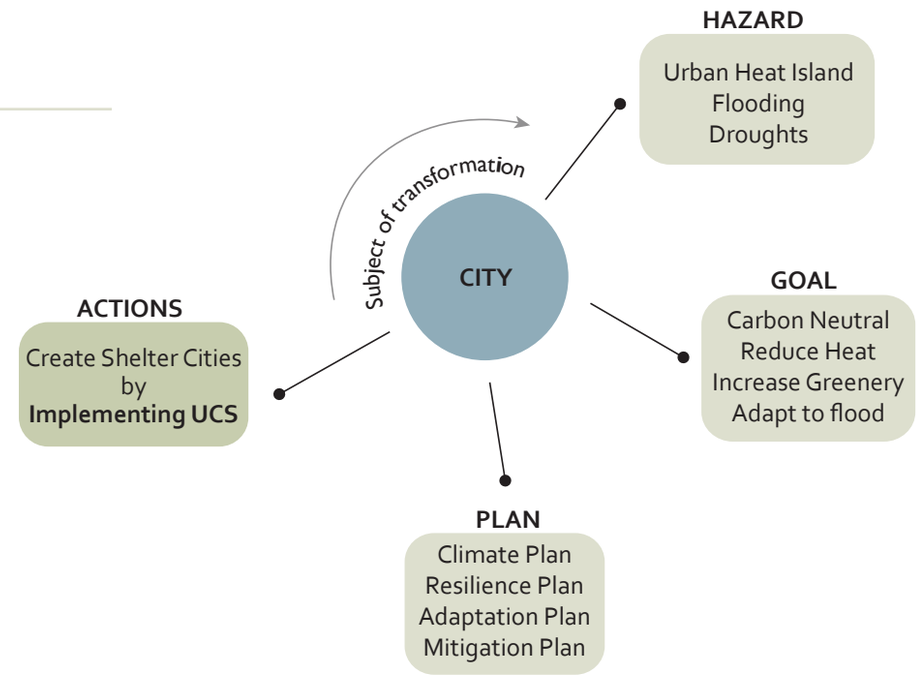
3



4



5



UCS MISSION

1. Understand the role cities play in accelerating climate change and providing awareness of climate change and local-level community engagement.

2. Transform existing spaces from traditional approaches to sustainable and natural ones, improving health and quality of life and adapting cities to climate change.

3. Schools maintain its function but open to the community in non-school hours, increasing access to green areas and providing shelter to vulnerable groups.

4. Upscaling in other sectors and facilities creating resilient and shelter cities, that are capable to adapt to current and future climate hazards

UCS RECOMMENDATIONS

Desirable Shelter city should provide UCS within walking distance, following the concept of compact city

When working with limited resources the choice of design elements should be made by prioritizing the elements that addresses more climate hazards

Ensure that UCS provides open access to public

Provide short and long-term replicability

Greenery should follow local biodiversity

1

Map climate hazards + social vulnerability

The first step is to understand the city's or urban area's risks and hazards in context such as floods, heat, droughts, landslides, etc. In addition to the identification of the most vulnerable groups, both to climate hazards and to social circumstances.

2

Identify local needs

Therefore, after mapping the climate hazards and social vulnerability it is possible to understand the needs, such as an increase in green spaces, more permeable areas, more shading areas, more areas for water management, etc.

3

Selection of schoolyards

Observation and selection of potential spaces for intervention such as schools, hospitals, libraries, public squares, and parking lots, not only limited to public spaces but all urban spaces with potential for transformation.

4

Engage stakeholders

Co-production of different stakeholders can ensure the successful implementation of UCS, therefore, by involving citizens, community, professors, students, parents, etc. at all stages of the process.

5

Co-design elaboration

Elaboration of the design combines all the previous steps, in addition to the use of design guidelines and natural elements. Moreover, considering the analysis made and ensuring the co-design from different stakeholders.

6

Ensure upscaling

Upscaling is above all the step to ensure the effectiveness of the shelter city. Furthermore, it allows the implementation by a single UCS, to a network of UCS in a shelter city, enhancing the adaptation to climate change.

1. HOW TO MAP CLIMATE HAZARDS AND SOCIAL VULNERABILITY?

• Analysis of the plans and policies available for the area under study;

• Understand what are the climate challenges that have occurred, and that might occur with more frequency in the future;

• Understand existing climate of the area under transformation can enhance the effectiveness of the implementation of Urban Climate Shelter;

• Verify infrastructures most exposed to the climate hazards;

• Identify the vulnerable groups presented in the area to be transformed;

• Identify where these groups are located spatially;

• Determine the areas where the vulnerable groups are highly concentrated.

2. HOW TO IDENTIFY LOCAL NEEDS?

• Provide analysis on the overlapping of climate hazards;

• Identify the areas with higher exposure to the climate hazards;

• Provide analysis on overlapping of social vulnerable groups;

• Identify the areas with higher concentration of vulnerable groups and higher need of change;

• Intersect areas with higher exposure to climate hazards and higher exposure of vulnerable groups;

• Map the areas with need of transformation;

• Map the areas that have a potential of enhancing the strategies for adaptation to climate change;

3. HOW TO SELECT SCHOOLYARDS?

• The selection of space should start by the most vulnerable areas, considering the climate hazards and the social vulnerability;

• Any square meter of de-paved area can become permeable and contribute to water flow;

• Any increase in greenery can be a benefit for decreasing the Urban Heat Island effect;

• Any space that enables the implementation of a rain garden, water fountain, plantation of trees and shading elements can become an Urban Climate Shelter;

• Any school that has a schoolyard can be transformed;

• Some places will have more changes than others;

• Remain materials can be used to build urban furniture and design elements used in schools such as playgrounds;

• The goal is not to transform completely the city area, but rather to have many small changes that provide larger benefits.

4. HOW TO ENGAGE STAKEHOLDERS?

• Engage the community, starting firstly from those who are immediately impacted, students, teachers, and parents;

• Promote activities with students addressing climate change and how they could change their schoolyards, understanding what they would like differently in their daily play area. Importantly the activities should be coherent with the age group of the students;

• Promote workshops that engage parents to participate in the school environment, spreading awareness of climate change and how their children can be positively impacted by the transformations of schoolyards;

• Promote lectures open for the community, to not only address climate change impacts in cities but to allow the community to be part of each step, such as participating in the ideas for the spaces to be transformed in UCS;

• With the engagement of other stakeholders such as NGOs promote workshops that allow manual activities such as the plantation of trees, and building urban furniture and playgrounds;

• Anything that is made with the co-production of the community has a greater chance of receiving care and therefore ensuring its preservation and management.

5. HOW TO ELABORATE THE CO-DESIGN?

• Provide analysis of context: understanding the context not only immediately but also the surroundings is a crucial step to ensure the positive accomplishment of UCS, therefore, including building mass, neighborhood analysis, street analysis, windy and solar analysis.

• Ensure multi-hazard approach: Understand the relationship between hazards, therefore increasing the capability for the same solutions to address different climate hazards.

• Ensure increase of green infrastructure: more green can cope with different hazards and improve quality of life for all.

• Prioritize use of natural materials: Natural-based materials can provide different benefits, such as a decrease in the albedo, therefore providing less hot areas to sit or play, other than ensuring sustainable usage of resources.

• Ensure use of permeable paving: Often characterized by natural paving, permeable paving can reduce heat, ensure permeability of the water, reduce the process of run-off water, and provide less harmful interventions.

• Provide blue infrastructure: water areas can provide multi-benefits therefore, when understanding the context it is possible to give solutions that go from the collection/slowdown process of water to a colling strategy.

6. HOW TO ENSURE THE UPSCALE?

• Strategies should refer to short and long-term periods, therefore understanding what are the areas that should be transformed first;

• The upscaling process should address areas with high exposure to climate hazards;

• Prioritize most vulnerable areas in the upscaling process;

• A coherent strategic proposal for upscaling should provide a comprehensive analysis of climate hazards + each vulnerable group, therefore, the overlapping of the information consists of the priority areas of transformation;

• Schools should be mapped and analyzed individually to understand the viability of the schoolyard;

• The upscaling process should go beyond schoolyards involving other sectors and facilities subsequently fostering resilient and shelter cities.

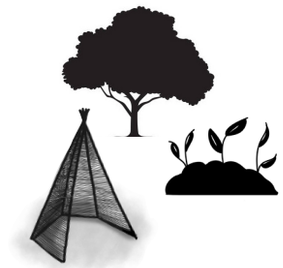
TOOLKIT FOR DESIGN ELABORATION

DESIGN ELEMENTS

CLIMATE HAZARDS

		DROUGHT	FLOOD	HEAT
	**SHADING ELEMENTS** Shading elements should be made by natural elements, and/or recyclable ones	H.A	H.A	H.A
	**PATH NATURAL MATERIALS** Natural path using sand, grass, gravel, wood, or any natural permeable material	M.A	H.A	H.A
	**FOUNTAIN** Drinkable fountain, playful fountain, ponds and etc.	H.A	L.A	H.A
	**WATER MANAGEMENT** Rain garden, bios wale, and other features for collecting and/or slowing down water	H.A	H.A	H.A
	**TREES** Increase the vegetation following local biodiverdity	L.A	M.A	H.A
	**PAVING NATURAL MATERIALS** Paving using natural materials that ensure the infiltration of the water	M.A	H.A	H.A
	**GARDEN** Bushes, flowers, wild vegetation, and etc	H.A	H.A	H.A

H.A: High Advantage M.A: Medium Advantage L.A: Low Advantage



Shading elements + Trees + Garden

Combining multiple elements such as shading elements, gardens, and trees can tackle the issue of heat waves and urban heat islands in urban areas. Therefore, reducing the micro temperature and providing a cooling and refreshment area.

Rain garden + Natural Paving + Natural Path

Combining these three elements can benefit flooding events, such as run-off water, sea level rise, etc. Due to its high capability of soil absorption and permeability of the water.

Trees + Water Management + Fountain

In drought climate elements that can store water such as bios wale and ponds can ensure the humidity of the soil, therefore, can be used to irrigate green spaces. Moreover, trees should be selected in accordance with the climate of the area.

CHAPTER 05.

UCS PILOT IMPLEMENTATION IN TURIN

Map 1: Italy highlighting Piedmont and Turin. Author's elaboration. Source: Science in the City.

Turin is located on the north of Italy in the Piedmont region. However, the city has its peculiarities, surrounded by Alps and with complex hydrological system, crossed by three large rivers (the Po, the Dora, and the Sangone). Furthermore, Turin was considered the industrial capital that propelled Italy's post-war economic recovery among automotive and mechanical manufacturing companies in the 1990s (Climate Resilience Plan, 2020). Given its industrial past and urban development, the city is highly impervious and prone to climatic hazards such as heat waves and flooding. Among these the impacts are numerous such as damages to infrastructure, increase on the energy consumption and beyond that can affect the health and the well-being as well as creating risk to human life. Nevertheless, Turin within their Strategic Green Infrastructure Plan aspires to be the greenest city in Italy and the greenest large city in Europe, therefore, some strategies for the future include mitigating vulnerabilities through ecosystems services, boosting ecological health and biodiversity, increasing connectivity among green areas, utilizing green infrastructure for greater social inclusion, and promoting cultural and outdoor tourism (Piano strategico dell'infrastruttura verde, 2020).

TURIN

No Urban Climate Shelter implemented

848.748 inhabitants – 130,01 km²
2.208.370 inhabitants – 6.827 km² metropolitan area

Maximum temperature: 39.4 2019

Main hazards:
- Heat waves
- Flooding
- Land slides

Sectorial plans related to climate change:
- Climate resilience plan
- Green infrastructure plan
- Action Plan for a Sustainable and Resilient Torino 2030

Urban Heat Island
- 27% of the area has low risk of heat island
- 44% of the area has medium risk of heat island
- 2% of the area has high risk of heat island

Flooding
- 60% of this area has low flood risk
- 29% of the area has medium flood risk
- 11% of the area has high flood risk

2030 development goals

- Development of 2.297,824 m² of new green space on public land, boosting 21% of recreational green space.;
- Development of extra 276,490 m² of recreational green space from private land (20% of all private areas to be redeveloped in accordance with the general Urban Master plan).

Emissions reduction targets

Target year	% Reduction
2020	45
2030	60
2050	100

(Climate resilience plan, 2020).
(Green infrastructure plan, 2020).

TEMPERATURE

2018 compared to 1971-2000 — Very hot nights in summer **+13**

Last 30 years — **Increasing trend of temperature**
Maximum temperature **+2 °C**

Urban Heat Island in Turin

Moderate danger area
44% of the territory

Near industrial buildings
+3 °C compared to the avarage of UHI

Strong association between **mortality** and **heat waves**

Mid 21st century

-CO2 with climate policies	**+CO2 without climate policies**
+ 29 days in a year	**+ 39** days in a year
+ 11 days duration	**+ 19** days duration
Days of heat wave per year	
On the rise	**Marked increase**
Mortality associated with heat waves	

Importance of adaptation in all scenarios

> Modified by author. Source: Climate Resilience Plan, 2020.

RAINFALL

Urban hydrographic network

Frequent phenomena of hydrogeological instability during heavy rains

- Very extensive with significant slopes
- Almost completely anthropized territory
- Many changes to waterways to benefit settlements

Flood risk management plan:
cities within significant risk areas
35 km²
flood risk area

60%	**29%**	**11%**
low risk	medium risk	high risk

Period **1928-2014** ---------- **Precipitation growth trends**
Annual maximum

Period **1951-2019** ---------- **Trend of slight increase**
in precipitation amount
on days when it rains a lot

Climate Change ---------- can worsen ---------- **Frequency and intensity of flooding episodes**

> Modified by author. Source: Climate Resilience Plan, 2020.

Temperature variation for different urban fabrics

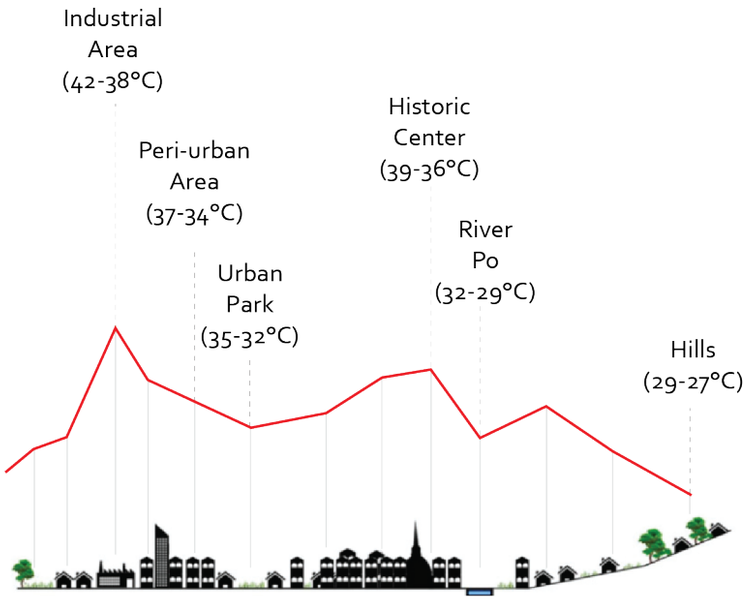


Figure 29: Temperature variation in different urban areas. Modified by author. Source: Climate Resilience Plan, 2020.

Infrastructure exposed to risks of heat wave, flood and integration of the two risks

Infrastructure	Urban Heat Islands	Flood	Multi risk
Hospital	24	6	5
Administrative services	133	22	7
Social-welfare services	93	16	23
Schools	444	53	65
Trade	23,503	2,458	1,426

Table 4: Infrastructure exposed to risks of heat wave, flood and integration of the two risks Modified by author. Source: European Green Capital Award, 2022.

SECTORIAL PLANS RELATED TO CLIMATE CHANGE

AND THE RELATIONSHIP WITH URBAN CLIMATE SHELTER

In Turin there are three main plans and policies related to the environment and adaptation to climate change. Therefore, in this research it was important to understand the relationship in between these plans and the implementation of Urban Climate Shelter. To begin with the climate resilience plan mentions the concept of climate refuge, where it categorizes the greenery as a strategy for the regulation of temperature, the strategy is to increase the usage of the hillside area of the city. Moreover, on the Action Plan for a Sustainable and Resilient Turin 2030 and the Green Infrastructure Strategic Plan the concept of climate refuge is not mentioned.

ACTION PLAN FOR A SUSTIANALE AND RESILIENT TURIN 2030

2019

- Does not mention climate refuge

CLIMATE RESILIENCE PLAN

2020

- Greenery as a **climate refuge**: greenery, in general, plays an important role in temperature regulation and, in particular, hillside woods are fundamental to this function for the city. At the same time, we intend to enhance greenery as a potential "climate refuge" and, in order to optimize this functionality, including for the hillside area, interventions will be carried out to increase its usability, providing rest areas, checking access routes, and increasing services (page 51) .

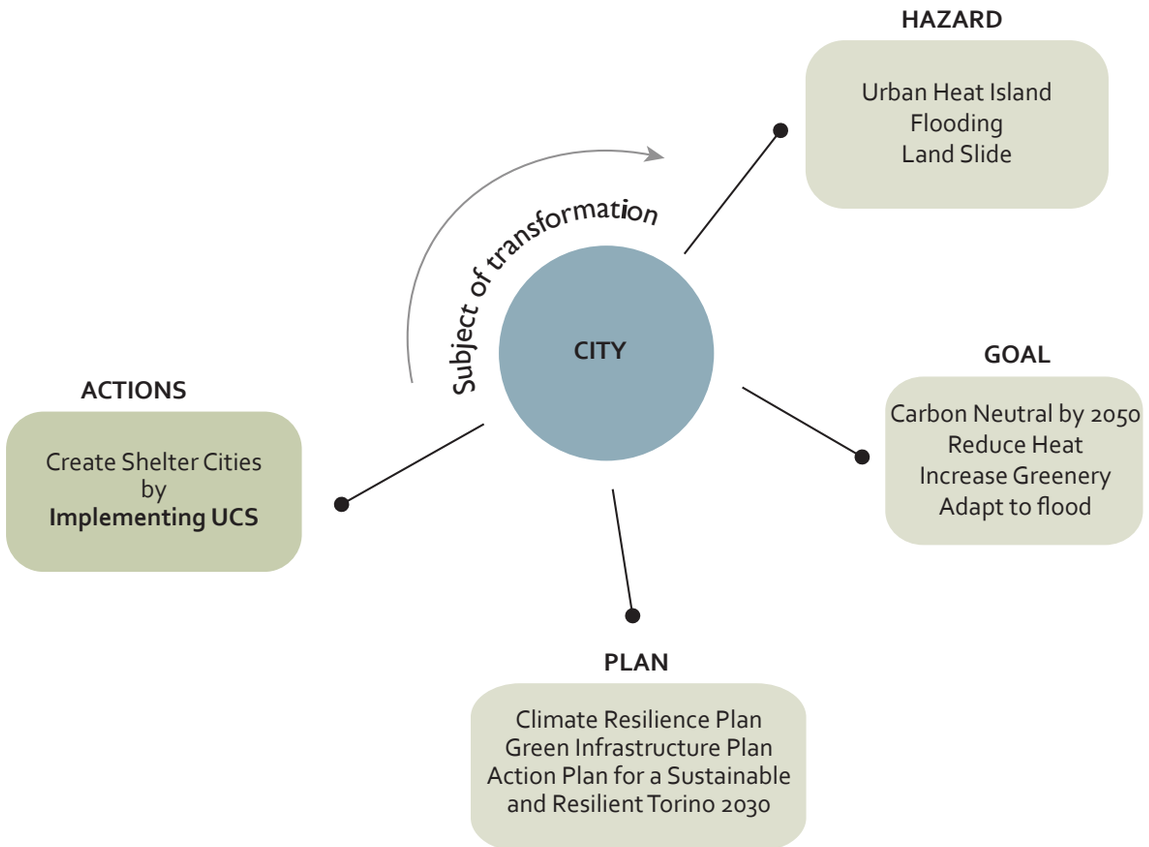
GREEN INFRASTRUCTURE PLAN

2020

- Does not mention climate refuge

IMPLEMENTING

Urban Climate Shelter in Turin



1. MAP CLIMATE HAZARD AND SOCIAL VULNERABILITY

CLIMATE HAZARDS

Urban Heat Island

Flooding

Two main climate hazards were identified in the city of Turin, hence Urban Heat Island and Flooding. In order to understand the impacts caused by them maps were produced, using data available from the municipality, and from the University of Politecnico di Torino (CLIMATE RESILIENCE PLAN, 2020). Referring to Urban Heat Island the analysis presents a spatial overview of the city, facilitating the understanding of the warmest spots, which are mainly located in the industrial areas, located on the southwest and northeast of the city. In addition, the city center also presents high levels of temperature due to its high densification and compact urban morphology. The data available also provides an overview of the temperature variation in different urban fabrics. Associated with flooding the analysis presents an understanding of low to high risk of areas affected by it. Furthermore, an analysis of infrastructures exposed to climate hazards reported 444 schools exposed to Urban Heat Island, 53 schools exposed to flooding, and 65 schools exposed to multi-hazards, thus representing more than 90% of schools in the city of Turin (European Green Capital Award, 2022).

SOCIAL VULNERABILITY

Children (Population Under 14)

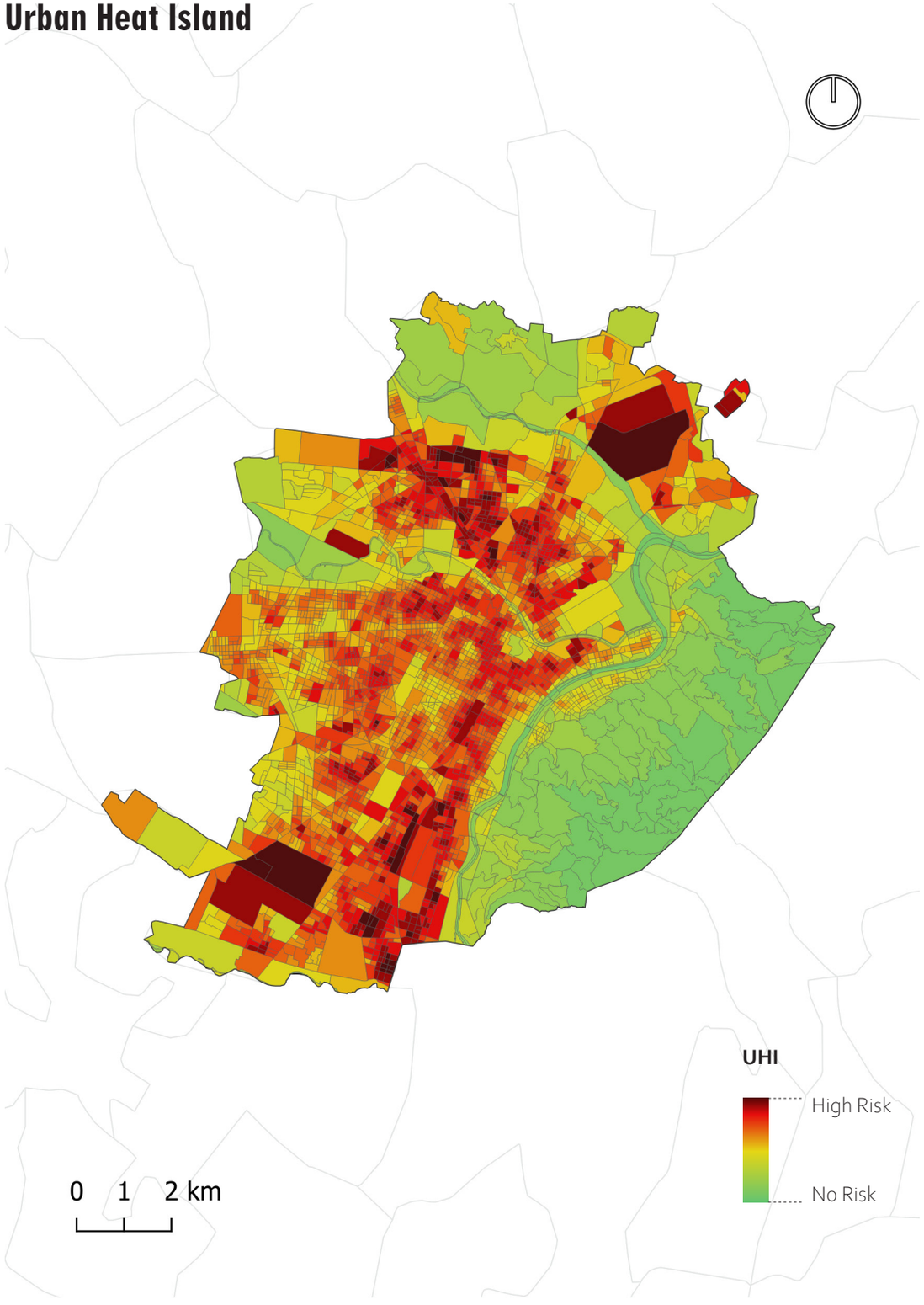
Elderly (Population Over 65)

Social Economic Disavantages

Foreign Population

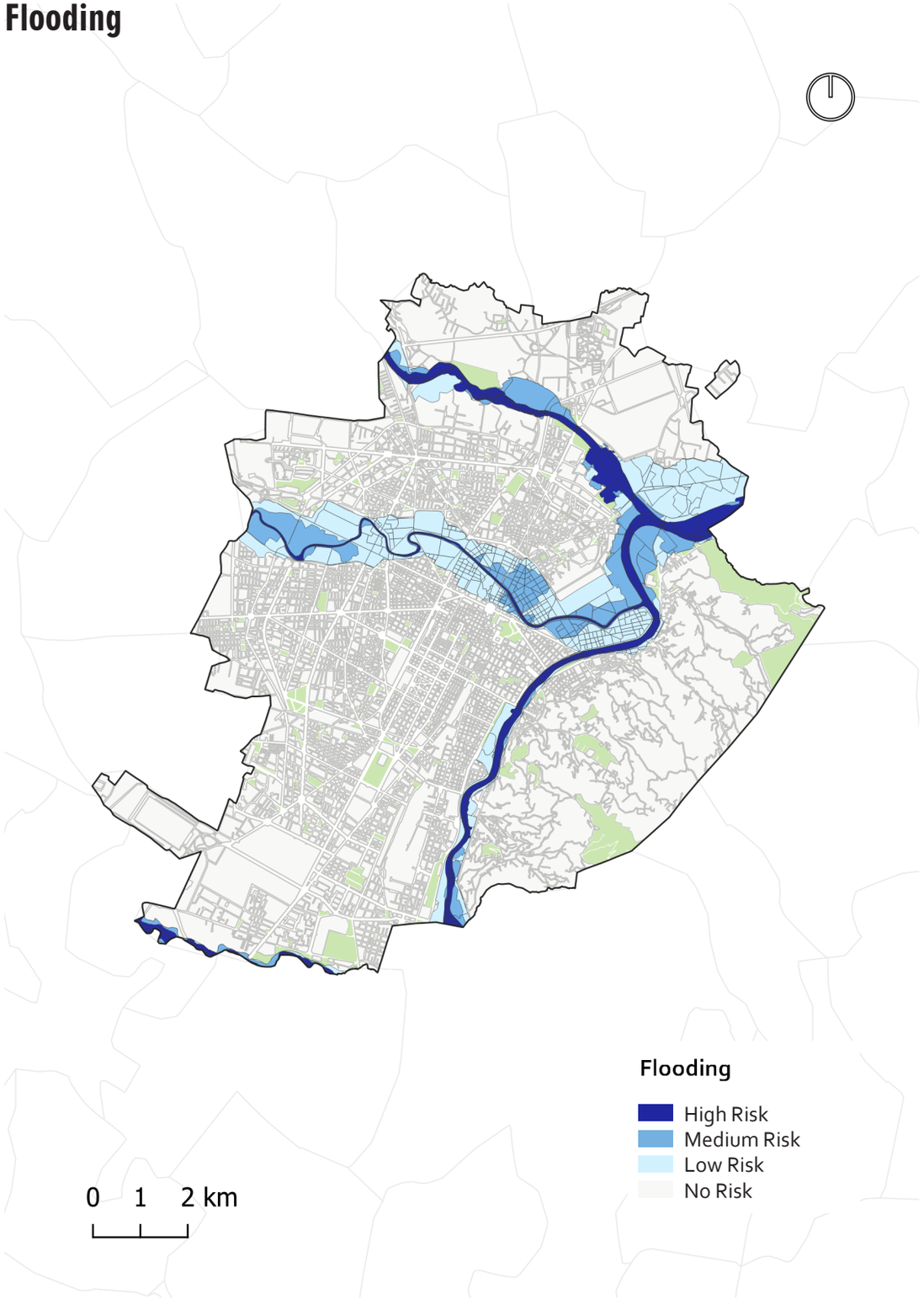
To enhance social equality, four vulnerable groups were identified. The first two groups are the children, characterized by a population under 14 years old, and the elderly, characterized by a population over 65 years old. These first two groups were identified specifically for representing higher vulnerability to heat events, and therefore, need special attention (Vetter, 2020). The other two groups are the foreign population and the population with low socioeconomic status, these groups are mainly identified as minorities, and with lower resources to cope with climate events. To produce the analysis the Empirical Bayesian Kriging method was used in Qgis, to achieve the results was used the data by urban cells for the groups of children, elderly, and foreign, and by neighborhood for the social economic status group. The data was available from the City of Turin website and the University of Politecnico di Torino. This method provides an interpolation of repeated simulations, therefore, highlighting the point where these groups are mostly present spatially. After each separated simulation, it was possible to provide an overlap of this information to achieve a synthesis and holistic analysis.

Urban Heat Island



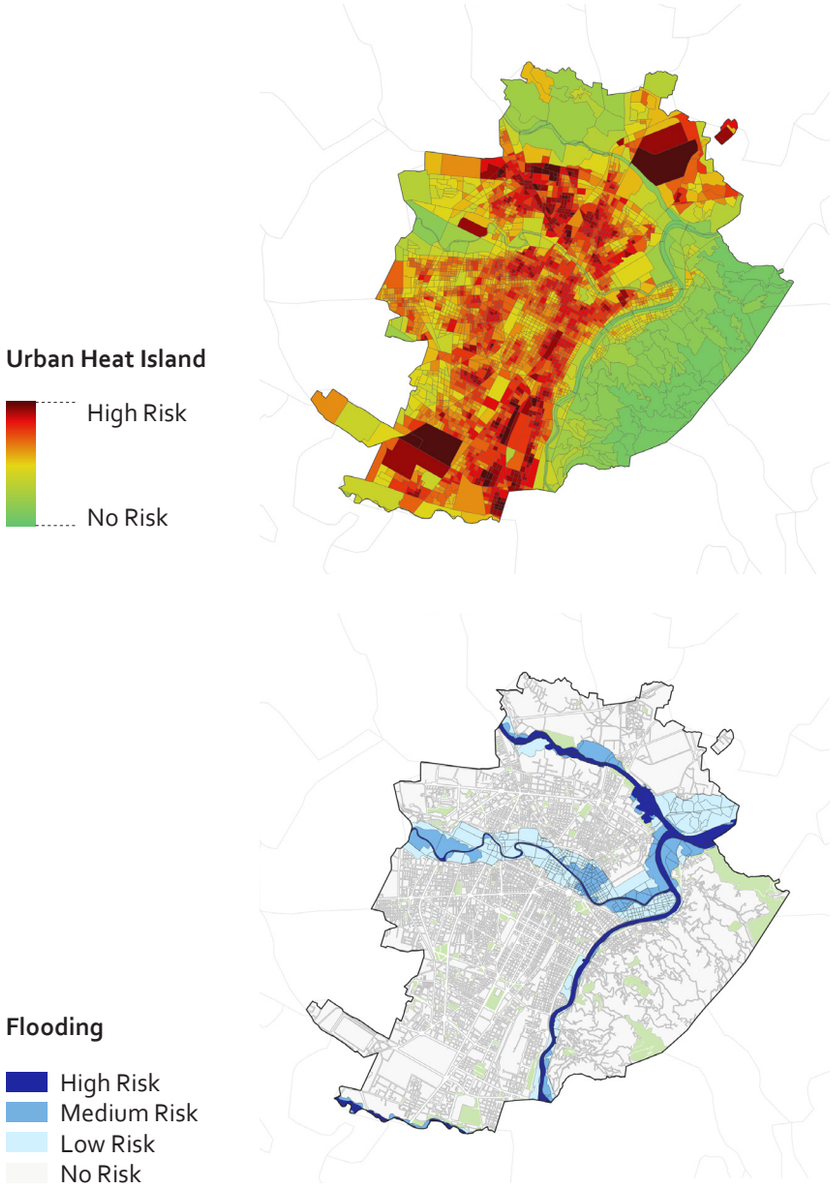
Map 2: Urban Heat Island in Turin. Author's elaboration. Source: Euro-Mediterranean Center on Climate Change (CMCC).

Flooding

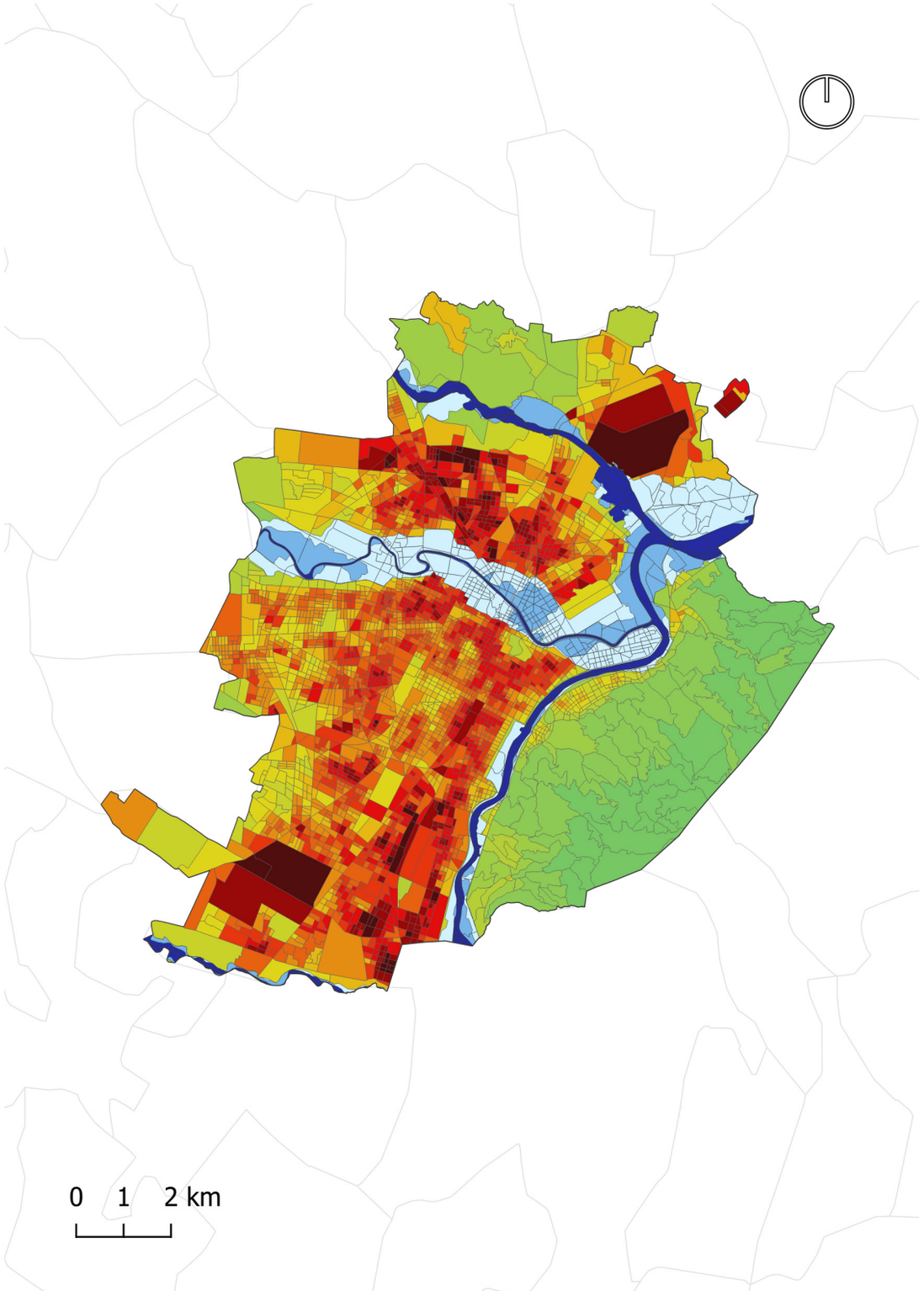


Map 3: Flooding in Turin. Author's elaboration. Source: Data from Climate Resilience Plan.

CLIMATE HAZARDS: synthesis analysis

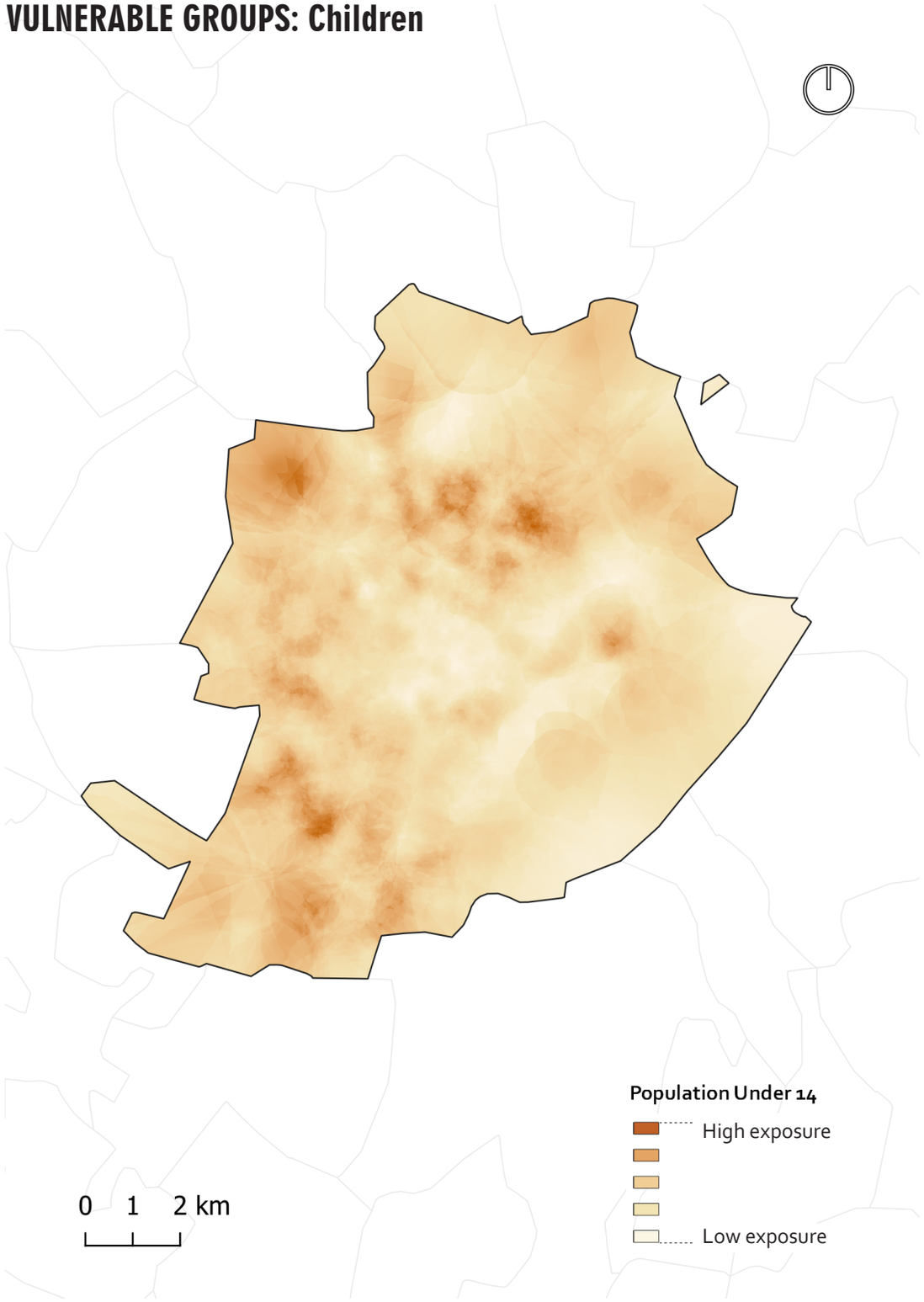


Map 4 and 5: Urban Heat Island and Flooding in Turin. Author's elaboration .



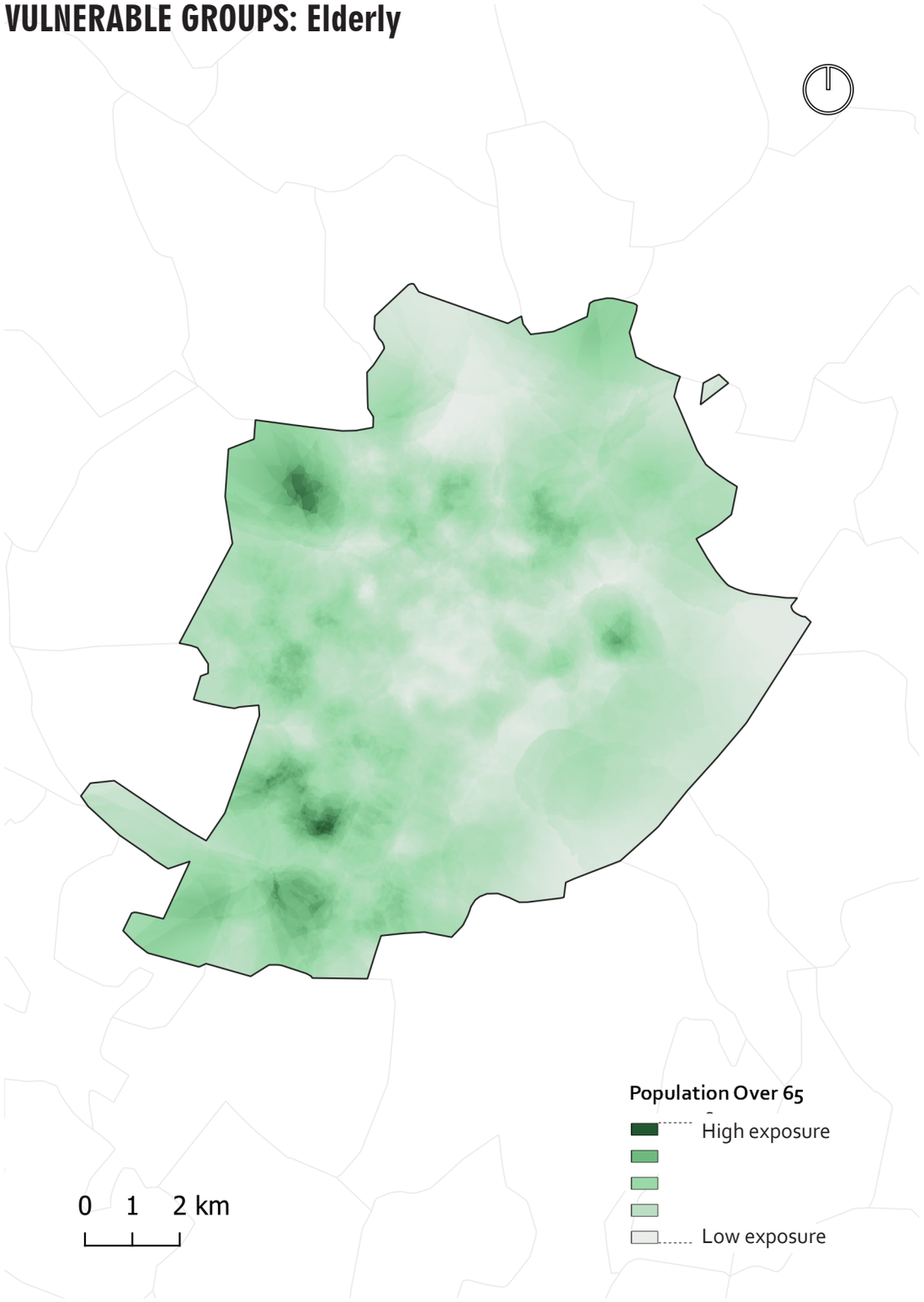
Map 6: Overlapping of Urban Heat Island and Flooding in Turin. Author's elaboration.

VULNERABLE GROUPS: Children



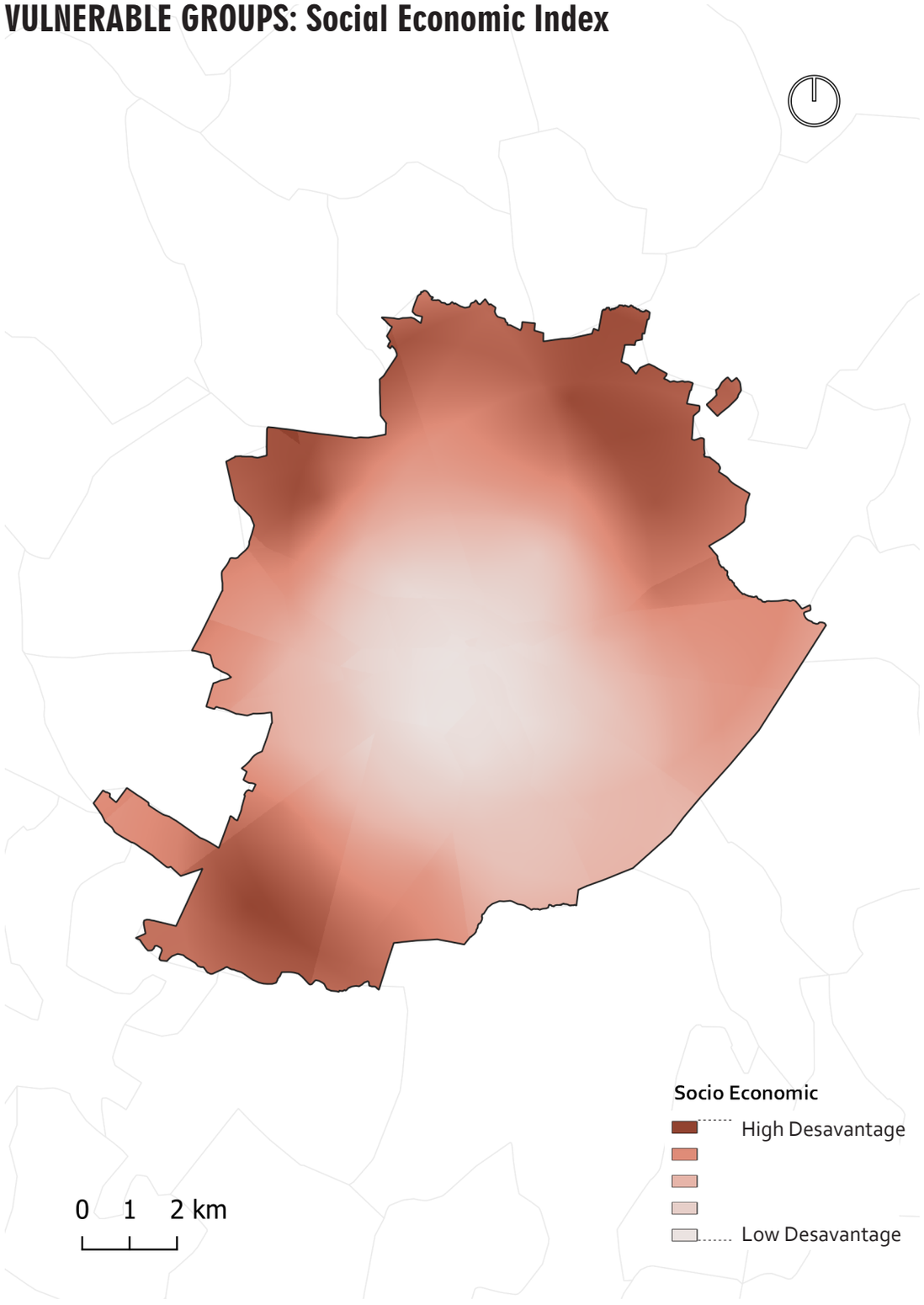
Map 7: Population under 14. Author's elaboration. Source: Uffficio di stastitica. Citta' di Torino (2022).

VULNERABLE GROUPS: Elderly



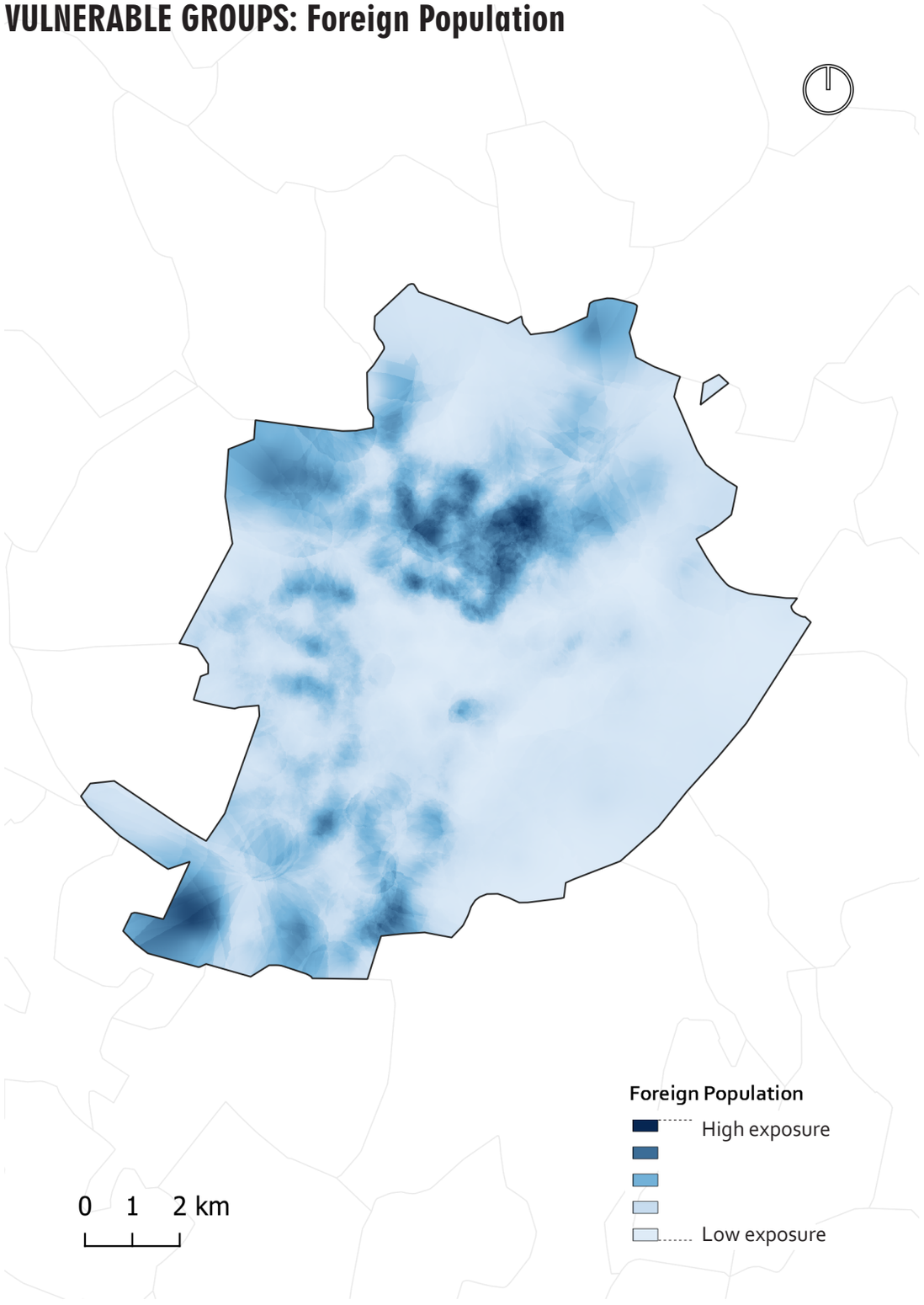
Map 8: Population over 65. Author's elaboration. Source: Uffficio di stastitica. Citta' di Torino (2022).

VULNERABLE GROUPS: Social Economic Index



Map 9: Socio Economic Data. Author's elaboration. Source: Geoportale, Indicatore socioeconomico della città di Torino (2022).

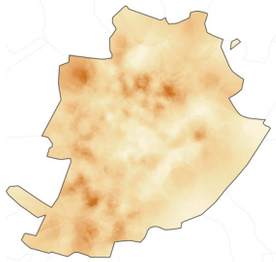
VULNERABLE GROUPS: Foreign Population



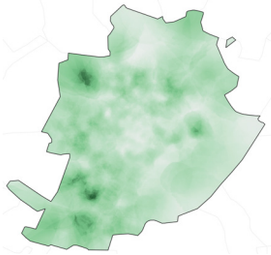
Map 10: Foreign Population. Author's elaboration. Source: Geoportale, Ufficio di stastitica. Citta' di Torino (2022).

VULNERABLE GROUPS: synthesis analysis

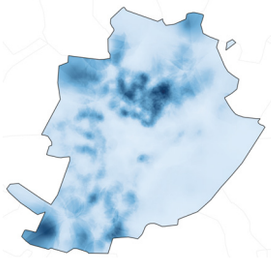
Children
Population under 14



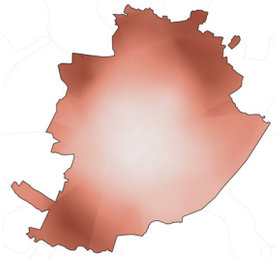
Elderly
Population over 65

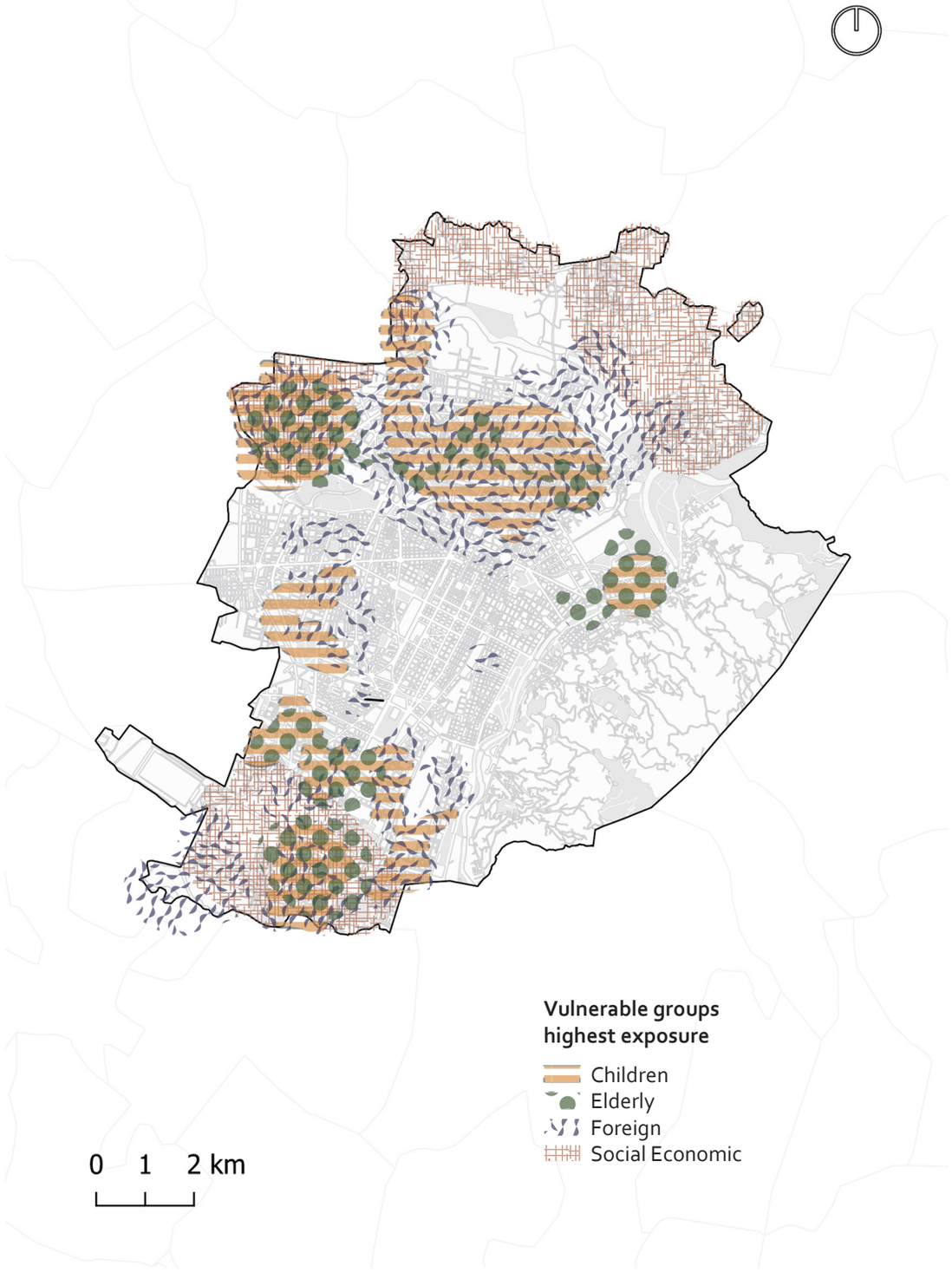


Foreign
Population



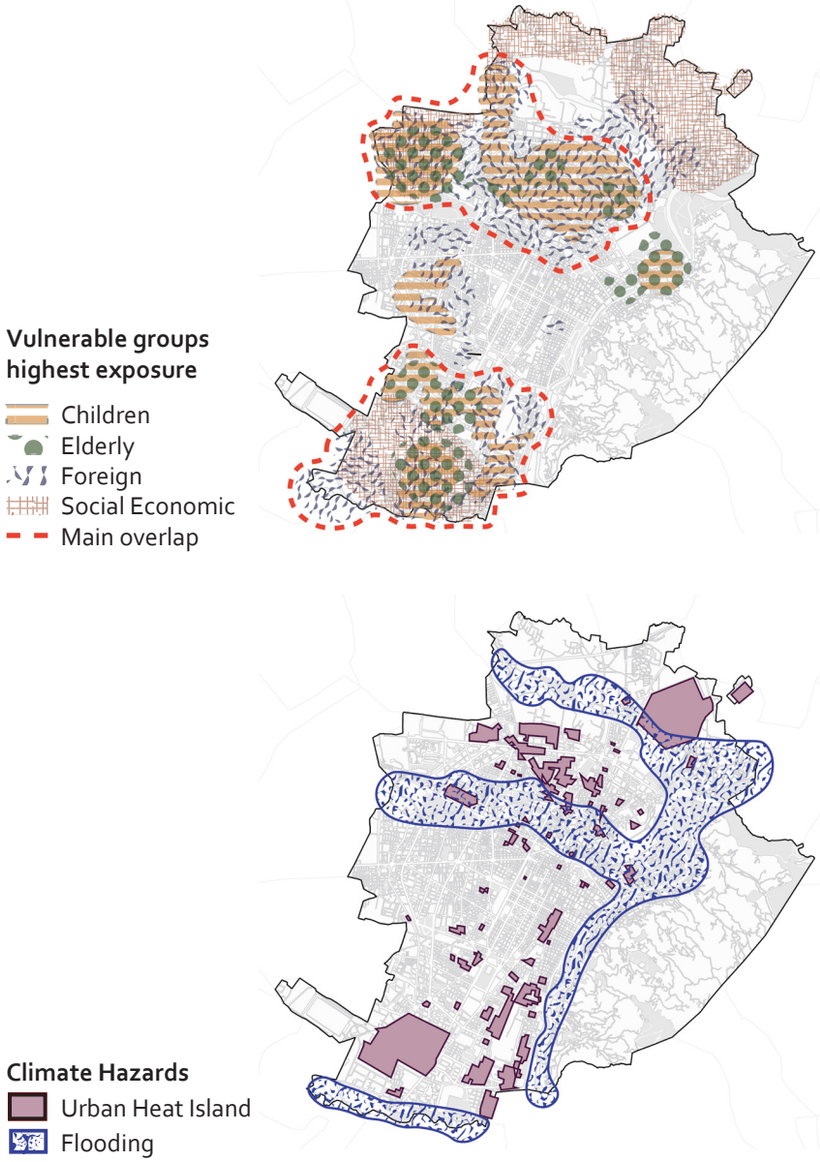
Socio Economic
Disavantage
Population





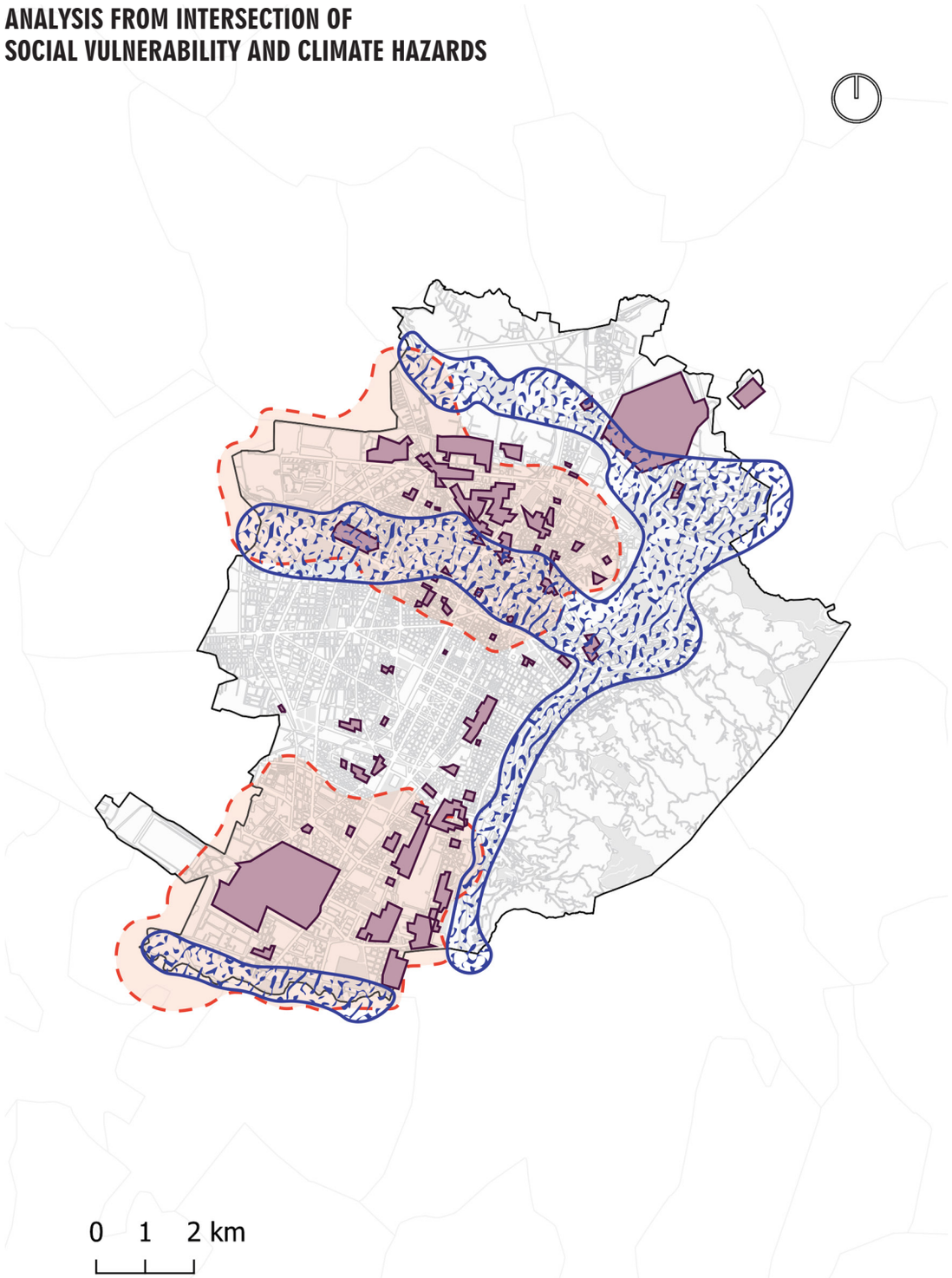
Map 11: Vulnerable groups highest exposure. Author's elaboration.

2. IDENTIFY LOCAL NEEDS



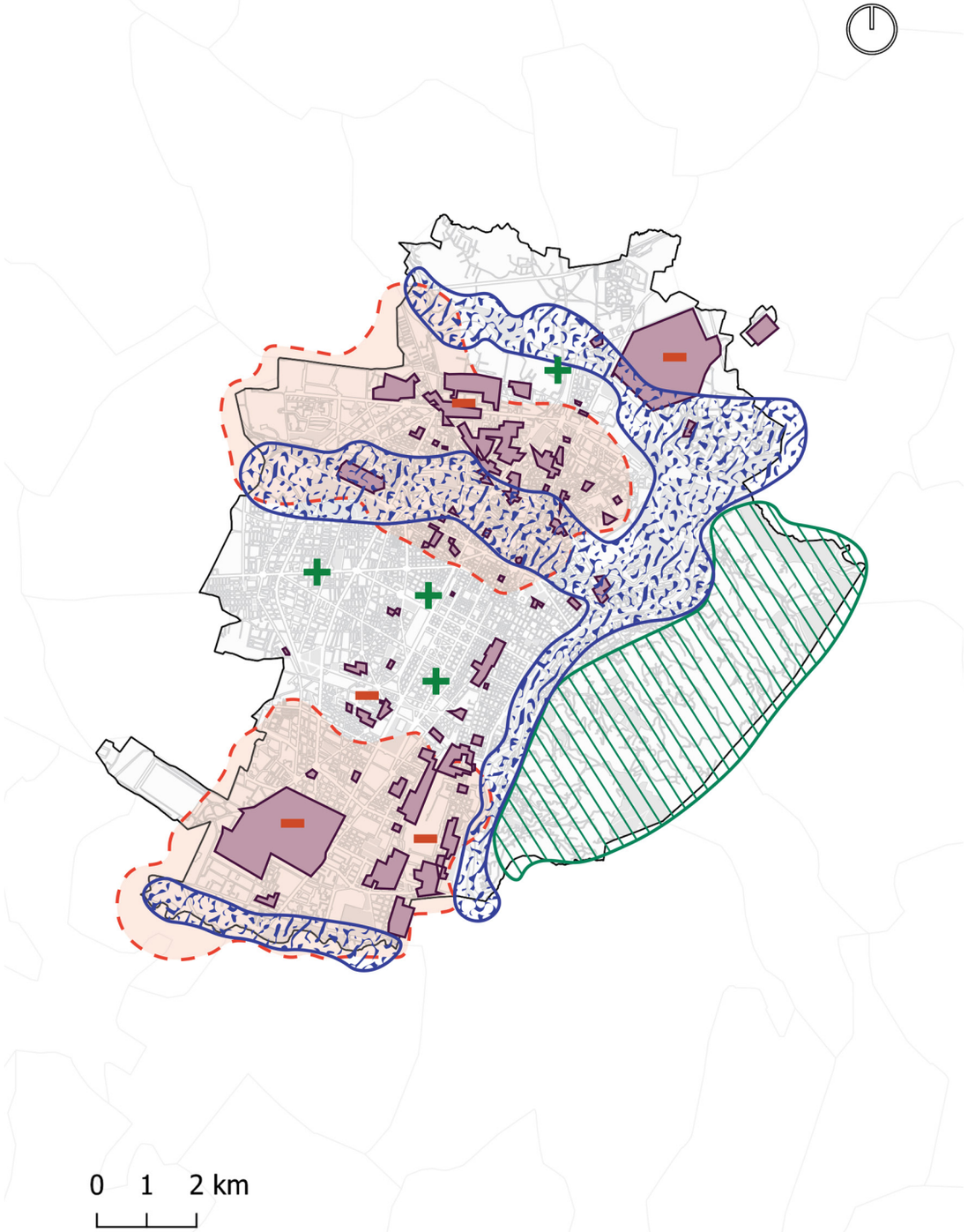
Map 12 and 13: Vulnerable groups highest exposure and Climate Hazards. Author's elaboration.

ANALYSIS FROM INTERSECTION OF SOCIAL VULNERABILITY AND CLIMATE HAZARDS



Map 14: Intersection of Social Vulnerability and Climate Hazards. Author's elaboration.

STRATETEGIES IDENTIFIED FROM THE INTERSECTION OF SOCIAL VULNERABILITY AND CLIMATE HAZARDS



COPE WITH URBAN HEAT ISLAND: Industrial areas have a high concentration of Urban Heat Island, consequently, they require special consideration.

COPE WITH FLOODING: In particular, near riverbanks, solutions for flooding must be provided, increasing the permeable area for water flow.

PRIORITIZE VULNERABLE GROUPS: The area with high concentration of social vulnerability should be the first area of transformation, therefore, enhancing just and green transition.

PROTECT THE HILLS: Given the significance of the hills for maintaining the harmony of the city's greenery, it is necessary to protect it.

COPE WITH LANDSLIDE: Landslides are presented in the hills there the need to avoid future development in the area.

IMPLEMENT UCS: According to the resilience plan of the city of Turin, the Hills are the are where UCS should be implemented.

INCREASE GREEN AREAS: Increasing green space is necessary, especially in the city center.

IMPROVE AIR QUALITY: Therefore, another need is to improve the air quality, through sustainable mobility, increase in greenery and reduction of emissions.

DECREASE SOIL SEALING: Highly paved and constructed area are presented in the city center, leading for the increase of climate hazards.

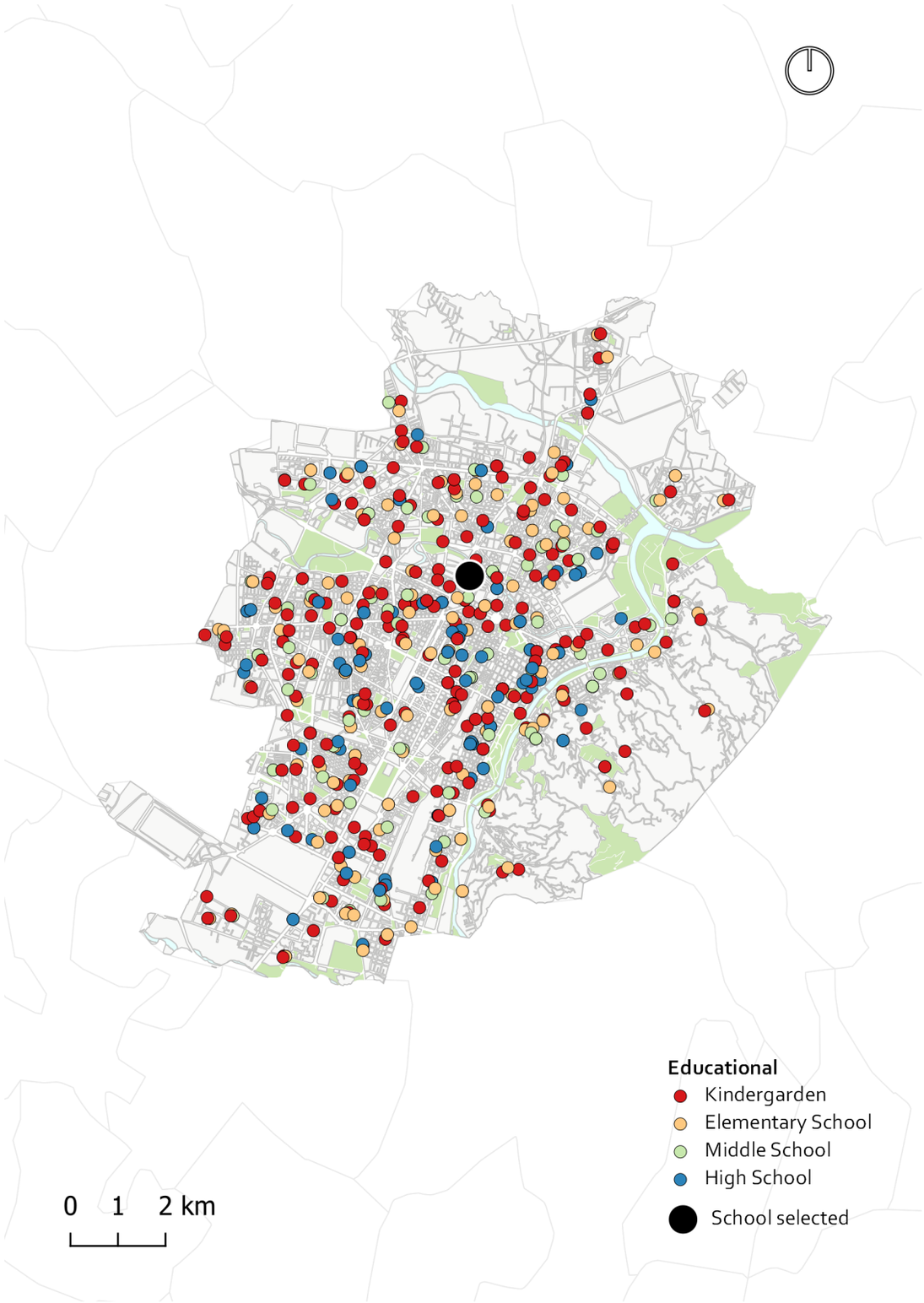
Map 15: Map of strategies. Author's elaboration.

3. SELECTION OF SCHOOLYARDS

SCHOOLS IN TURIN

610
Schools

- 218 Kindergartens
- 143 Elementary schools
- 87 Medium schools
- 162 High schools
- + 29 Universities



Map 16: Schools in Turin. Author's elaboration.

SCHOOLS IN TURIN
AND THE EXPOSION TO CLIMATE HAZARDS

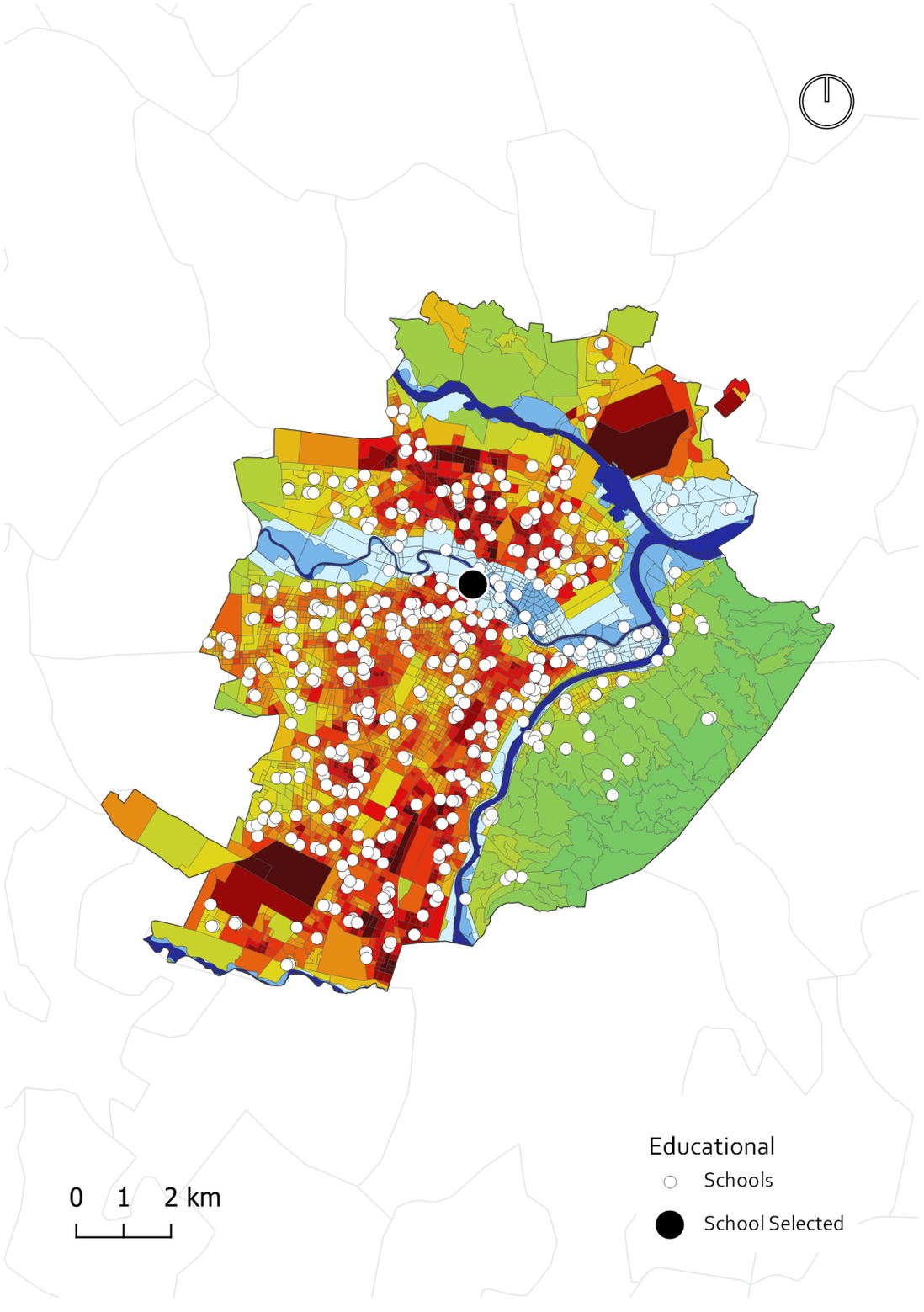
Climate Resilience Plan (2020).

92%
Exposed to Climate Hazards

444 schools
exposed to UHI

53 schools
exposed to Flooding

65 schools
exposed to Multi Hazard



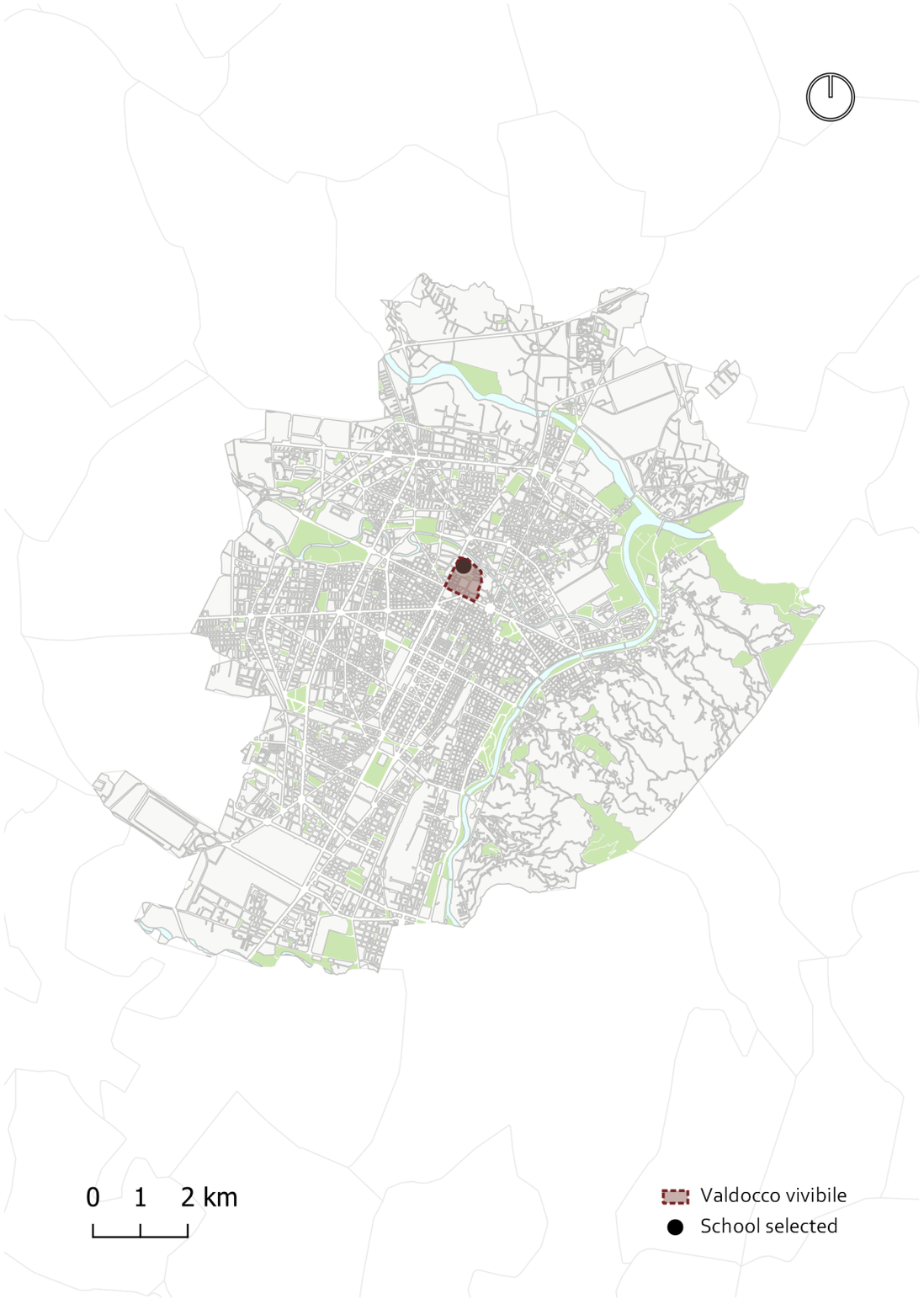
Map 17: Schools in Turin and the exposion to climate hazards. Author's elaboration.

VALDOCCO AREA

According to the Strategic Plan of the city of Turin Valdocco area has already a plan to become a climate proof neighborhood (PIANO STRATEGICO DELL'INFRASTRUTTURA VERDE, 2020). Nevertheless, the project has focus on the road infrastructure and, considering that the area is characterized by 90% of the public spaced representing with roads or parking. Livable Valdocco aims to shift this scenario to a better one, therefore, by increasing the greenery, coping with as urban heat island and rainwater management. (web livable valdocco). Moreover, the interventions are target to the redesign of sidewalks, crosswalks bringing more area for pedestrians, for greenery and for the management of the water.

LIVABLE VALDOCCO TURIN GREEN INFRASTRUCTURE PLAN

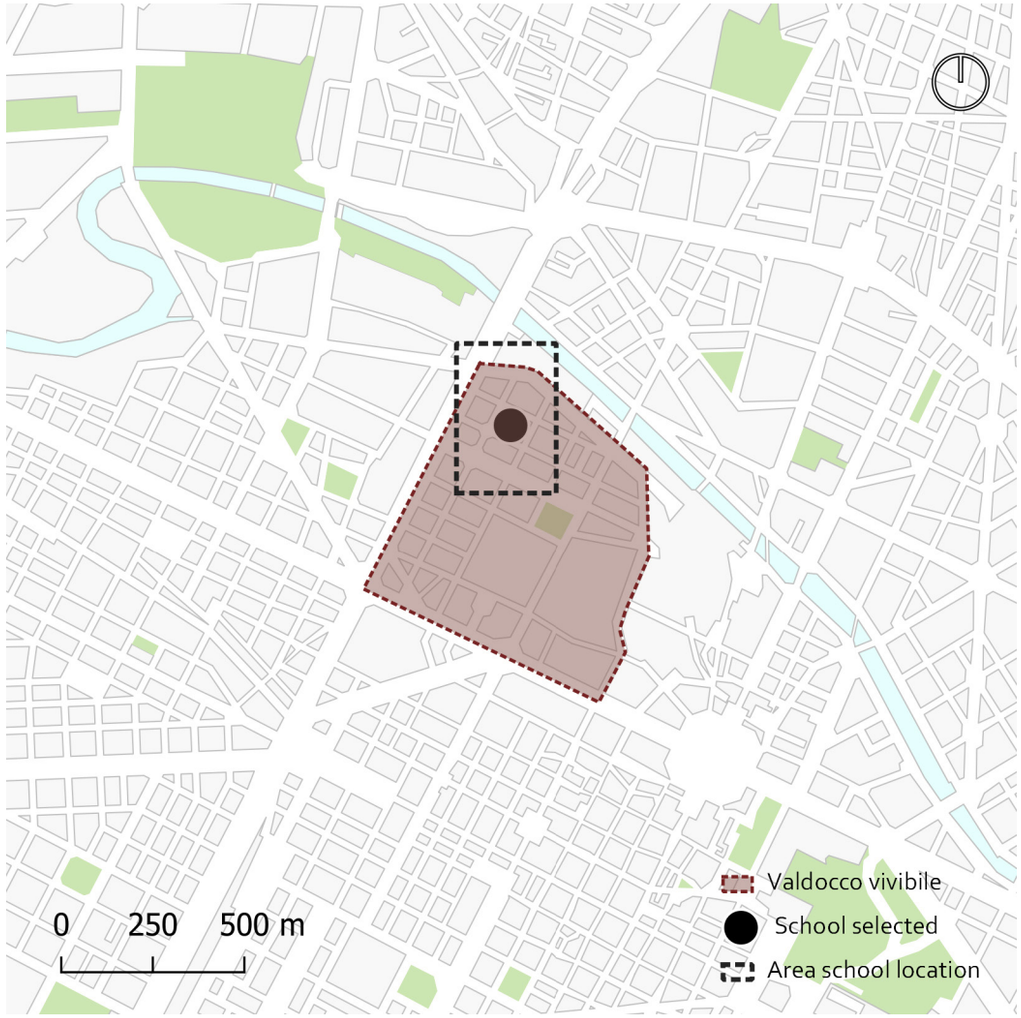
"The objective is the experimentation of several solutions aimed at counteracting the heat island effect and useful for the management of rainwater while creating a more livable urban environment. In this way it will be possible to create an abacus of intervention modules that can be easily replicated in other parts of the city characterized by a similar urban fabric to adapt it to new climatic scenarios".(PIANO STRATEGICO DELL'INFRASTRUTTURA VERDE, 2020).



Map 18: Valdocco area. Author's elaboration.

SCHOOL SELECTED

The selected space for a pilot intervention is a medium school located in the north area of valdoco, just meters of distance from the Dora river.



Map 19 and 20: Location of School Selected for Intervention. Author's elaboration.

4. ENGAGE STAKEHOLDERS

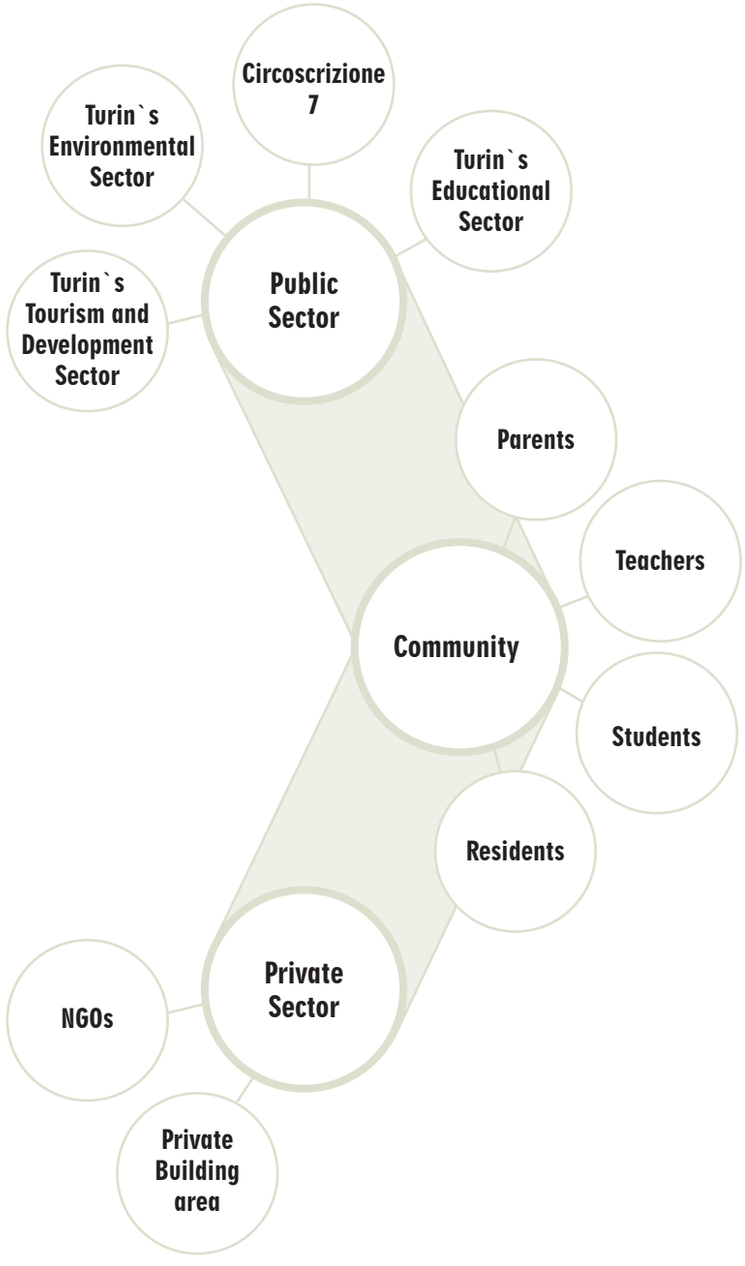
CO-PRODUCTION AND AWARENESS

To engage co-production and awareness a series of strategies are created. Thus, workshops, webinars, courses, seminar for discussion and disperse of the knowledge, educational activities, and etc. The main objective is to address the highest number of stakeholders, therefore engaging public and private sector, as well as the community that represents the core of the transformation. For each stakeholder group a different strategy is necessary. Finally, it is essential the involvement of the three groups for the elaboration of co-design of each schoolyard.

POTENTIAL STAKEHOLDERS

• Environment Area, Technical Environmental Compliance Service, Soft Mobility Service, Civil Protection Service, Tourism and Development Service, ITER, Po Torinese Park Authority - MAB Unesco, Municipal Police Force. (Green Infrastructure Plan, 2020)

• Private Building Area, Public Building Area, Infrastructure Area, Mobility Area, Social Policies Area, Civil Protection Area, Urban Planning and Quality of the Built Environment Area, Green Area European Projects Service, Innovation AXTO Project Service - Public Assets - Suburbs Energy Management Office. (Climate Resilience Plan, 2020)



5. CO-DESIGN ELABORATION

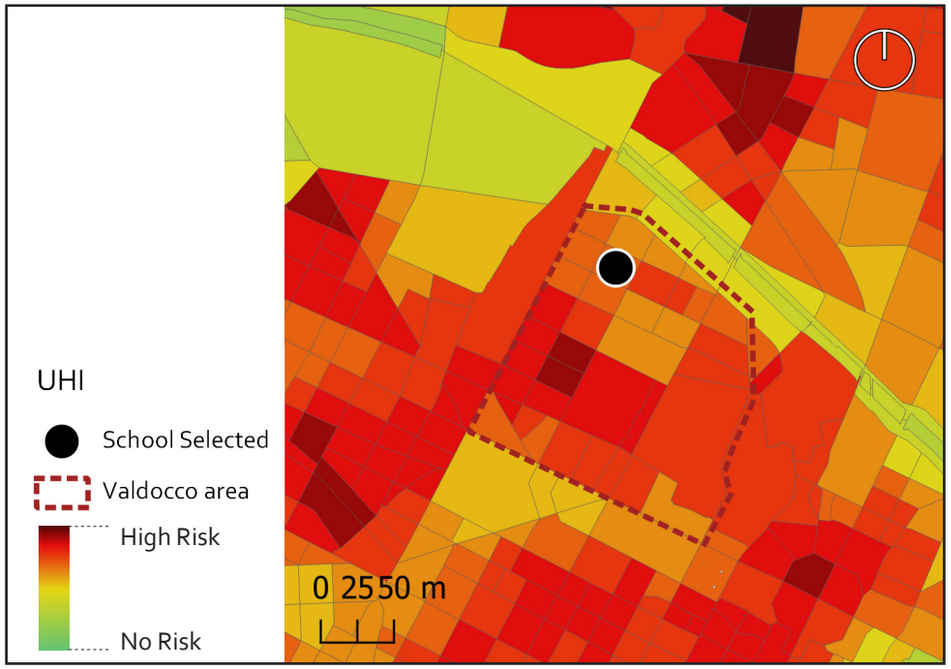
Design elaboration process require a set of steps. The first one refers to the local analysis of the climate hazards identified in the city of Turin. Following by the landscape analysis , comprehending the surround area of the school and its schoolyards. Solar analysis is the third step and it is important to provide insight on the sun direction and lightest spots in the area. The final step points to the thermal analysis of the school area specially to cope with hazards such as Urban Heat Island.

- CLIMATE HAZARD ANALYSIS
- SOCIAL VULNERABILITY
- LANDSCAPE ANALYSIS
- SCHOOLYARD ANALYSIS
- SOLAR ANALYSIS
- THERMAL ANALYSIS

CLIMATE HAZARD ANALYSIS

URBAN HEAT ISLAND

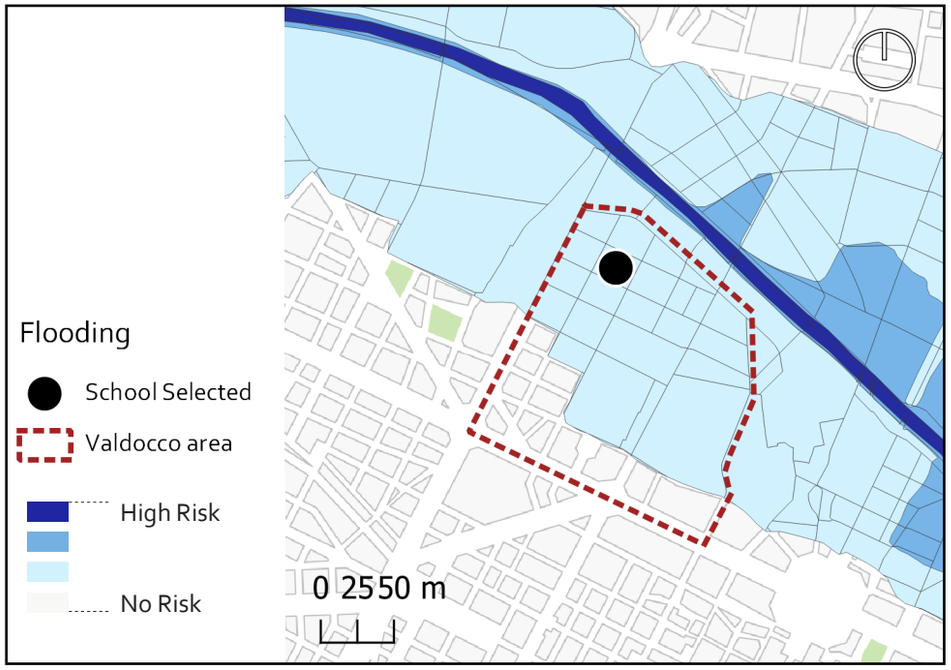
MEDIUM TO HIGH RISK



Map 21: Urban Heat Island analysis in Valdocco area. Author's elaboration.

FLOODING

LOW TO MEDIUM RISK



Map 22: Flooding analysis in Valdocco area. Author's elaboration.

SOCIAL VULNERABILITY ANALYSIS

ELDERLY

NO EXPOSURE

FOREIGN

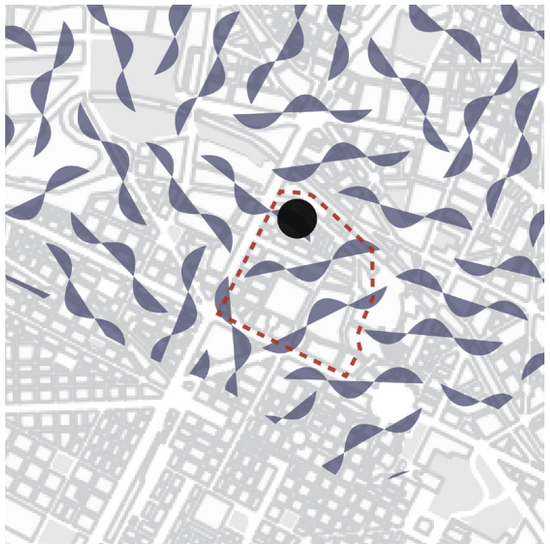
HIGH EXPOSURE

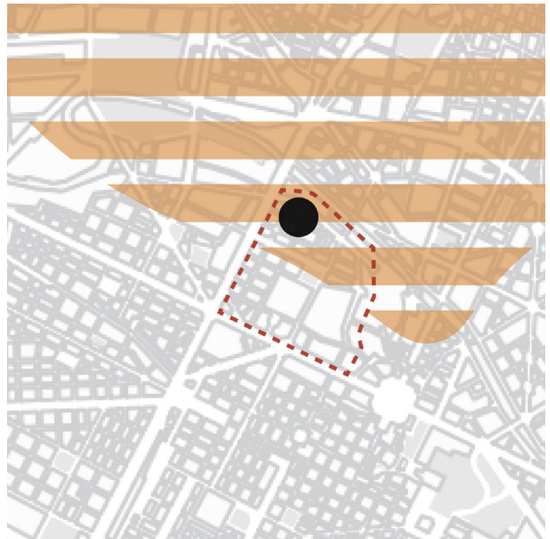
CHILDREN

HIGH EXPOSION

SOCIO ECONOMIC DISAVANTAGES

NO EXPOSURE





Elderly population no exposure

School selected

Valdocco area

Foreign population high exposure

School selected

Valdocco area

Children population high exposure

School selected

Valdocco area

Socio economic disavantage population no exposure

School selected

Valdocco area

Map 23: Elderly exposure in Valdocco area. Author's elaboration.
Map 24: Foreign exposure in Valdocco area. Author's elaboration.
Map 25: Children exposure in Valdocco area. Author's elaboration.
Map 26: Socio Economic Disavantages exposure in Valdocco area. Author's elaboration.

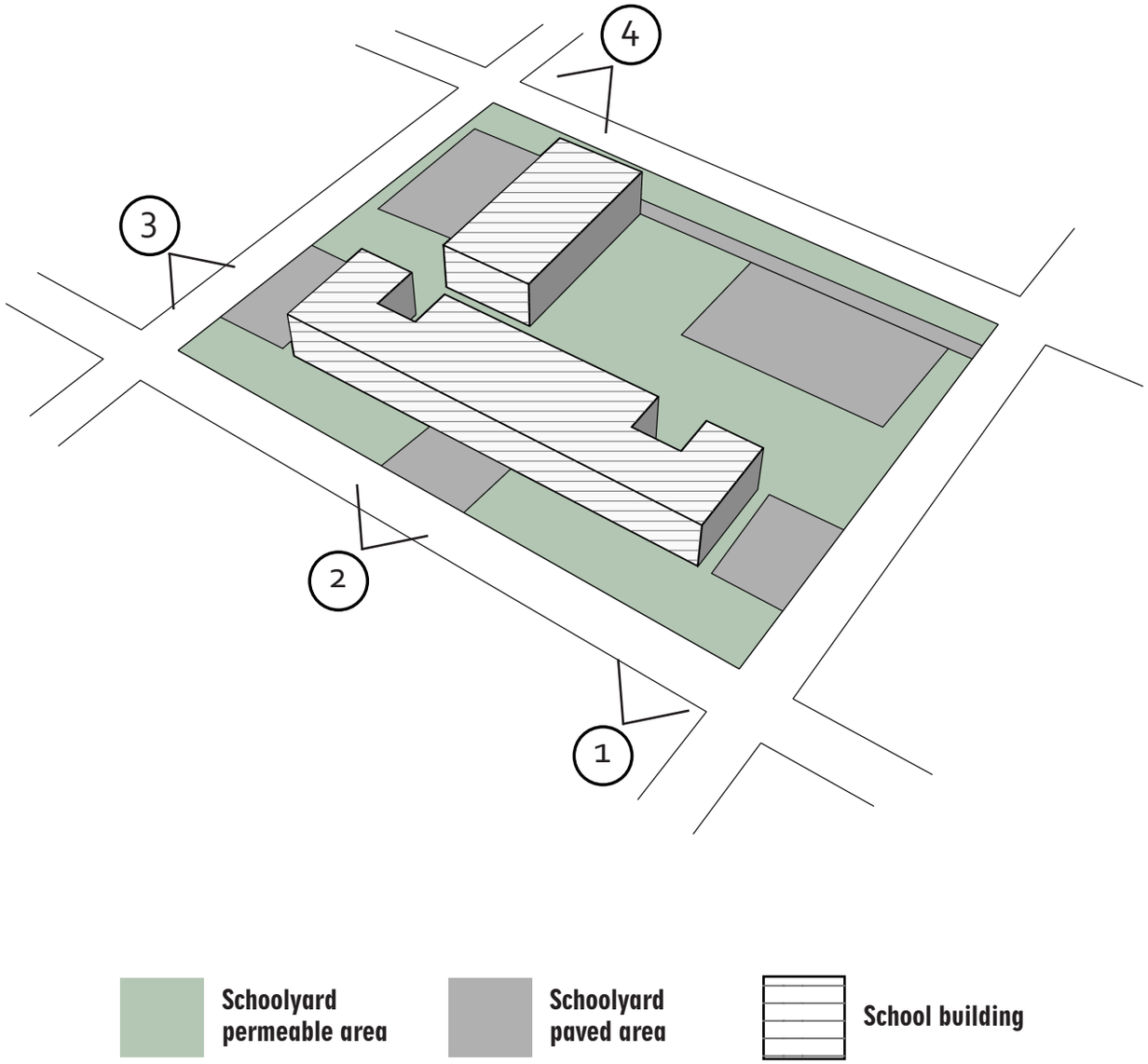


Figure 30: Landscape analysis. Source: Author's elaboration.

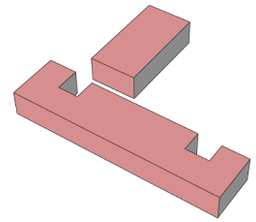
LANDSCAPE ANALYSIS

Figure 31: School side image on August 2, 2023. Source: Author's elaboration.
Figure 32: School entrance image on August 2, 2023. Source: Author's elaboration.
Figure 33: School side entrance image on August 2, 2023. Source: Author's elaboration.
Figure 34: School sports field image on August 2, 2023. Source: Author's elaboration.

SCHOOLYARD ELEMENTS ANALYSIS

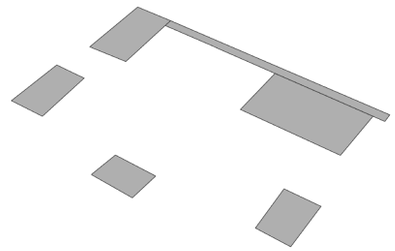
24 %

BUILDING SURFACE



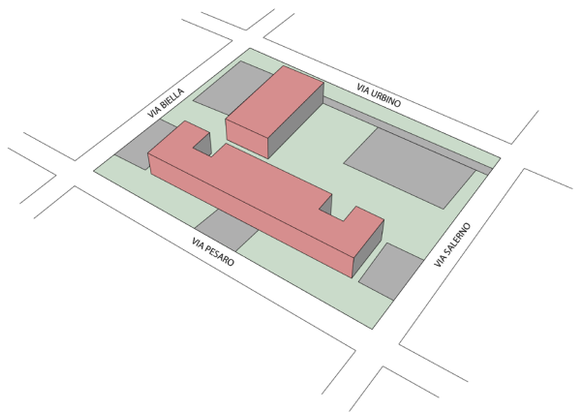
32 %

PAVED AREA



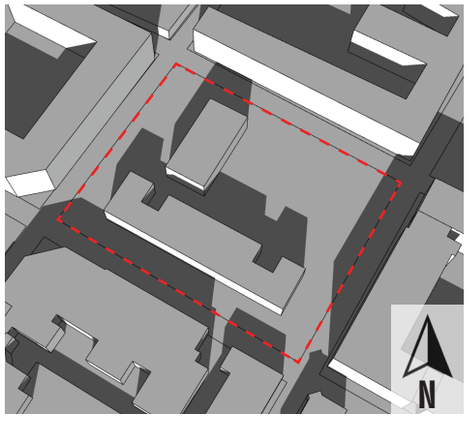
44 %

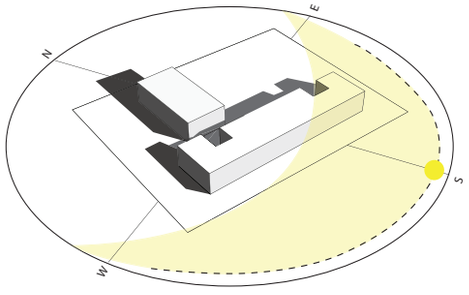
PERMEABLE AREA



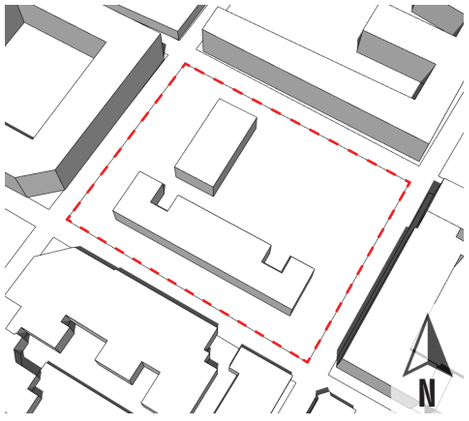
SOLAR ANALYSIS

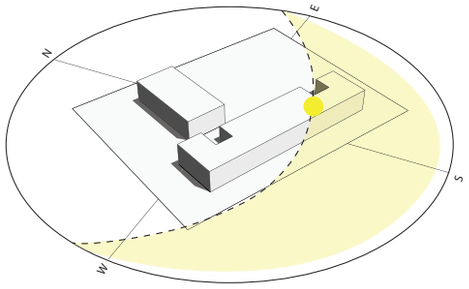
21 DECEMBER, 2022 at 12:30



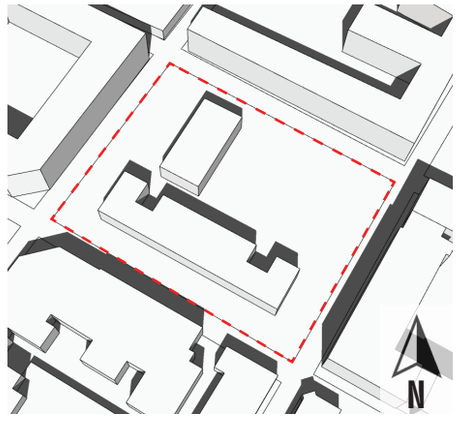


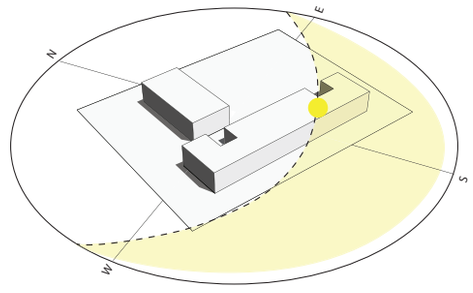
21 JUNE, 2022 at 12,30



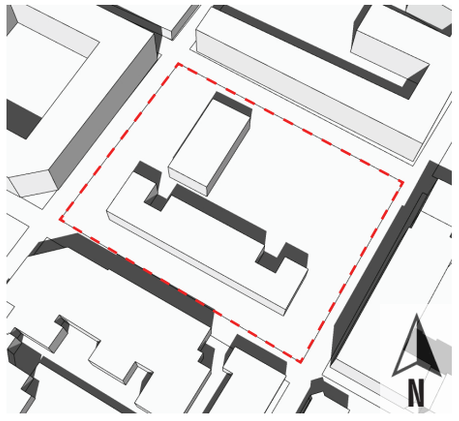


21 MARCH, 2022 at 12:30





21 SEPTEMBER, 2022 at 12:30



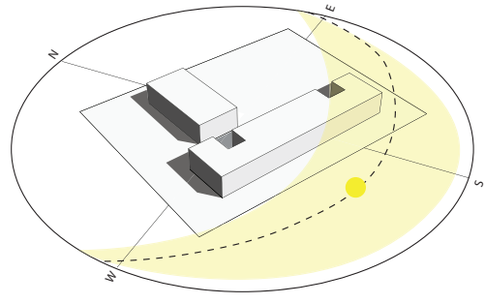


Figure 35: Solar analysis of schoolyard,21 of december 2022 at 12:30 . Source: Author's elaboration.
Figure 36: Solar analysis of schoolyard,21 of march 2022 at 12:30 . Source: Author's elaboration.
Figure 37: Solar analysis of schoolyard,21 of june 2022 at 12:30 . Source: Author's elaboration.
Figure 38: Solar analysis of schoolyard,21 of september 2022 at 12:30 . Source: Author's elaboration.

THERMAL ANALYSIS

Thermal analysis are an important and crucial step for the design development process, therefore to run the analysis the software ENVI-met was used. The steps necessary are firstly the redraw of the area in analysis, therefore, providing information related to the soil if permeable or not, such as the building mass details. Moreover, another step carried was the air temperature including maximum and minimum numbers observed in a chosen day, thus, on first of July of 2021 the minimum temperature was 26.64°C and the maximum 29.75 °C. However, given that Turin recorded a maximum temperature of 39.4 °C, these numbers do not characterize the warmest summer days. The following step refers to windy analysis, reported as maximum of 9.2mph on July 1,2021, blowing predominantly from a single direction during daylight hours. Furthermore, the analysis allows a visualization of the warmest spots in the school environment, which it is then used for the development of the design proposal.

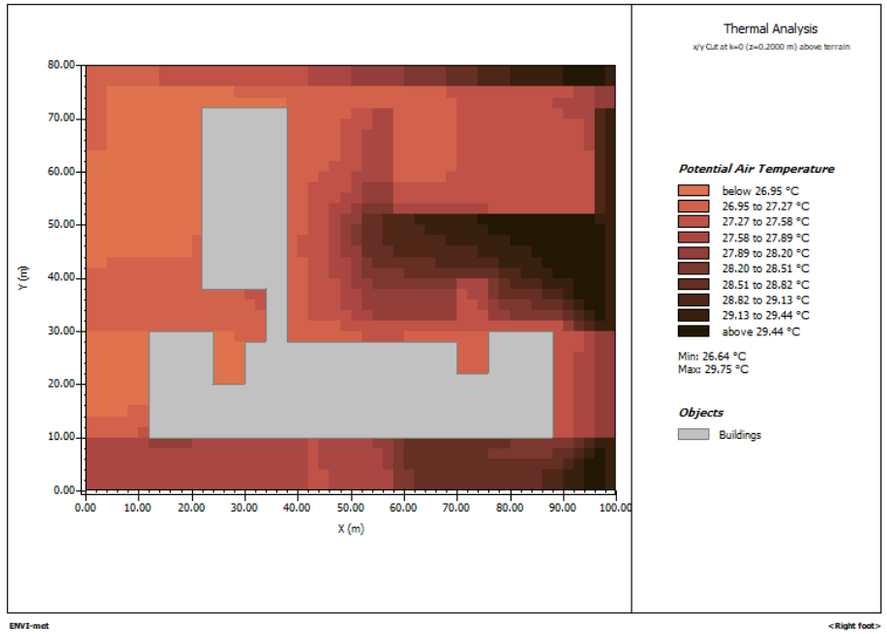


Figure 39: Thermal analysis topview. Source: Author's elaboration.

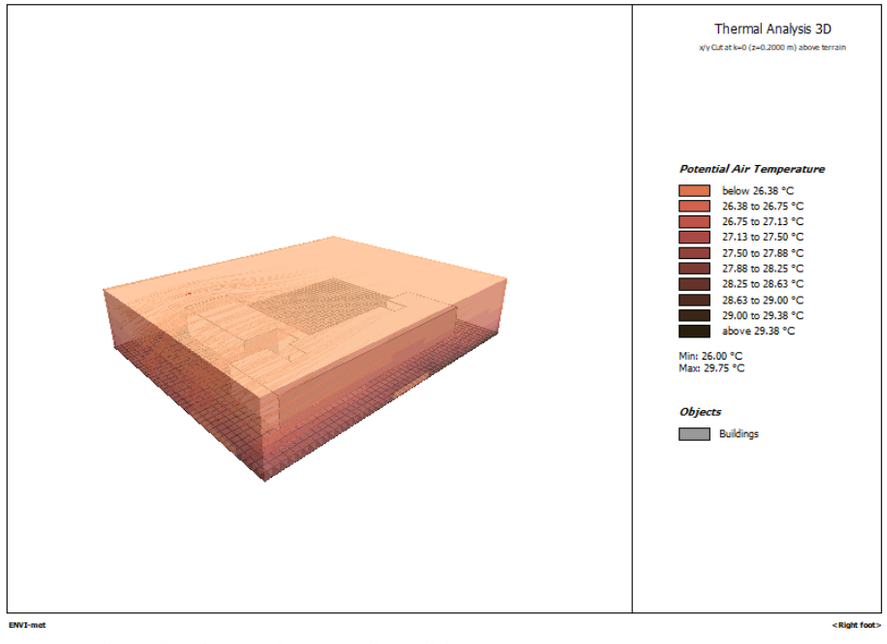


Figure 40: Thermal analysis 3D. Source: Author's elaboration.

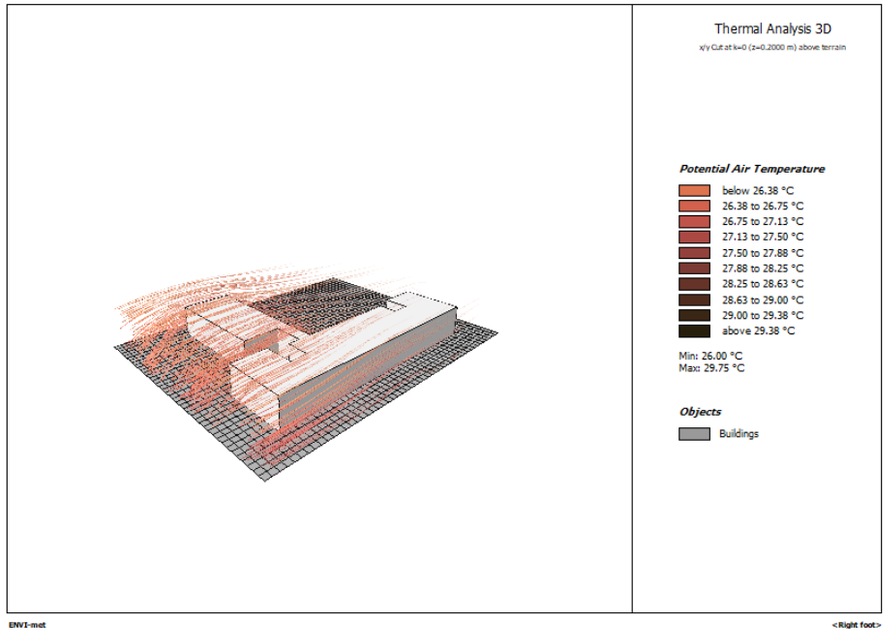


Figure 41: Thermal analysis 3D wind direction. Source: Author's elaboration.

KEY FINDINGS ANALYSIS

To observe holistically the analysis of the previous steps strategy used was to develop a scheme with key findings. Therefore, through this approach, it was possible to identify five main categories. The first one related to the thermal analysis where it provided the most warm area in the school perimeter. The second finding was from the solar analysis to understand where the sun irradiates more. The following finding was related to the area of flooding, and for this step, two observations were necessary, firstly to understand the location of the school and the location of the river and therefore the direction of the water, subsequently the other observation was done from the flooding map. The building mass and schoolyard analysis provided insight into the largest area available for changes. Furthermore, each of the key findings was used as a starting point for the development of the design strategy.

Figure 42: Map of key findings on analysis. Author's elaboration.

Figure 43: Design elements implemented in schoolyard. Source: Author's elaboration.

DESIGN ELEMENTS

1. Water management

2. Garden

3. Permeable path

4. Shading elements

5. Water fountain

6. Increase greenery

DESIGN PROPOSAL

Following the design stages, the design proposal's strategy focused primarily on comprehending the school's setting and providing the essential analysis, such as how to deal with flooding and urban heat island, two of Turin's main climate hazards. Additionally, besides the current greenery presented in the schoolyard the potential for increasing vegetation is always a benefit. Furthermore, the use of natural materials and the expansion of permeable paving were offered. Last but not least, the blue infrastructure was created by the use of rain gardens and bios wale for the process of collection and slowing down the water demand.

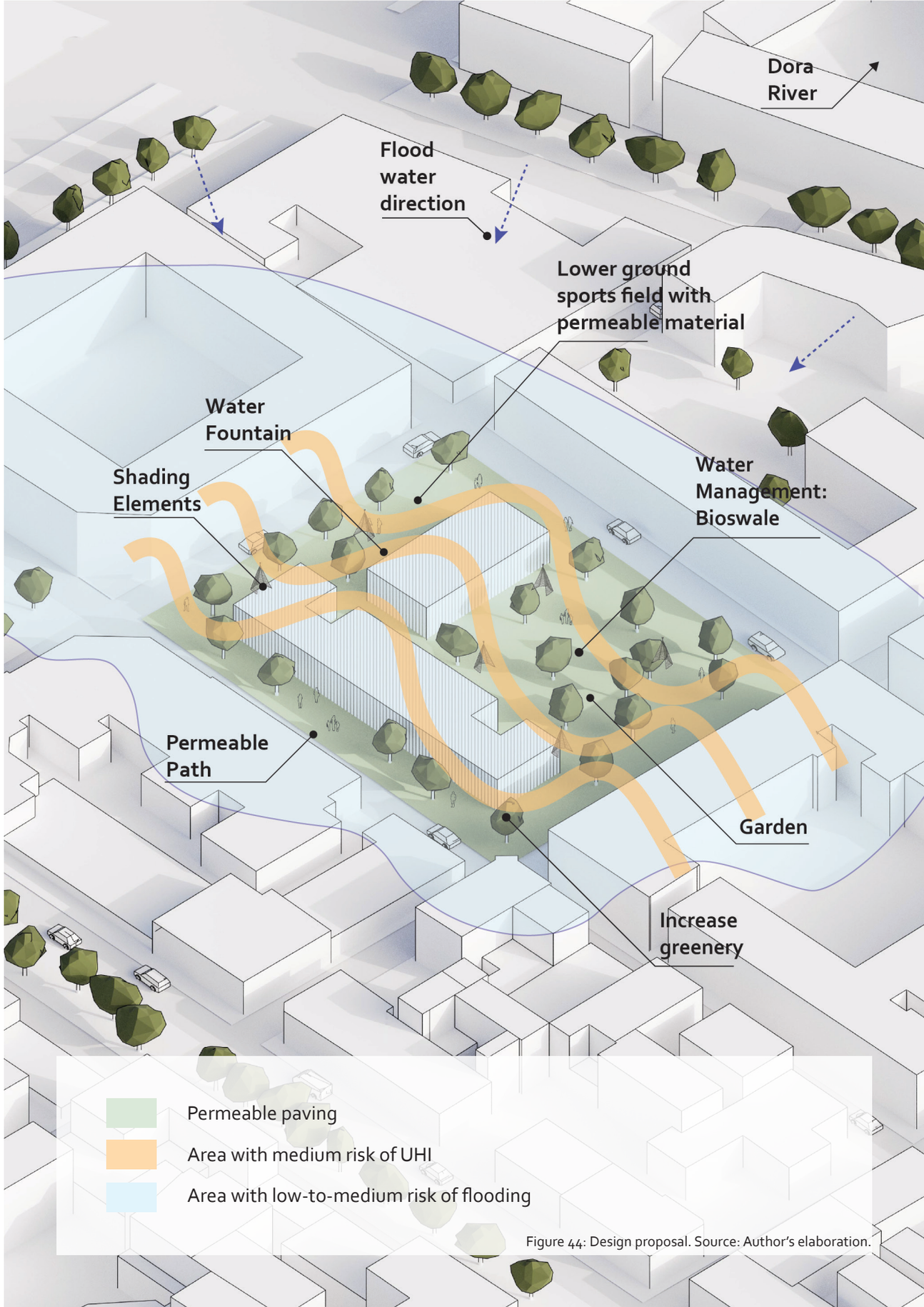


Figure 44: Design proposal. Source: Author's elaboration.

6. UPSCALING IN TURIN

2030
80 Kindergarten

2040
All Kindergarten
53 Elementary Schools

2050
All 610 Schools
All 29 Universities

2050 onwards
Beyond Schoolyards

Recognizing the significance of scaling up in the process of Urban Climate Shelter, the strategy for the city of Turin is to first prioritize the transformation in the most vulnerable areas (presented with the overlapping of climate hazards and social vulnerability, with a high concentration of children, elderly, foreign and social economic desavantages. Therefore, the first step is to focus on kindergartens in the vulnerable areas, since it is the first stage of the educational program and it addresses the youngest children. The second step refers t o transforming all 218 kindergartens in the city plus the elementary schools in the most vulnerable areas. Achieving the transformation of all schools and universities in Turin is the third step. Finally, it encourages the transformation beyond schoolyards. It is crucial to realize that the potential areas for upscaling were addressed in this research as a starting point, without determining whether the area is appropriate for the project. For instance, a detailed analysis of each space is required to comprehend the viability of the areas for upscaling.

Strategy

step 1. By 2030 Selected Kindergarten in most vulnerable areas will be transformed into Urban Climate Shelter

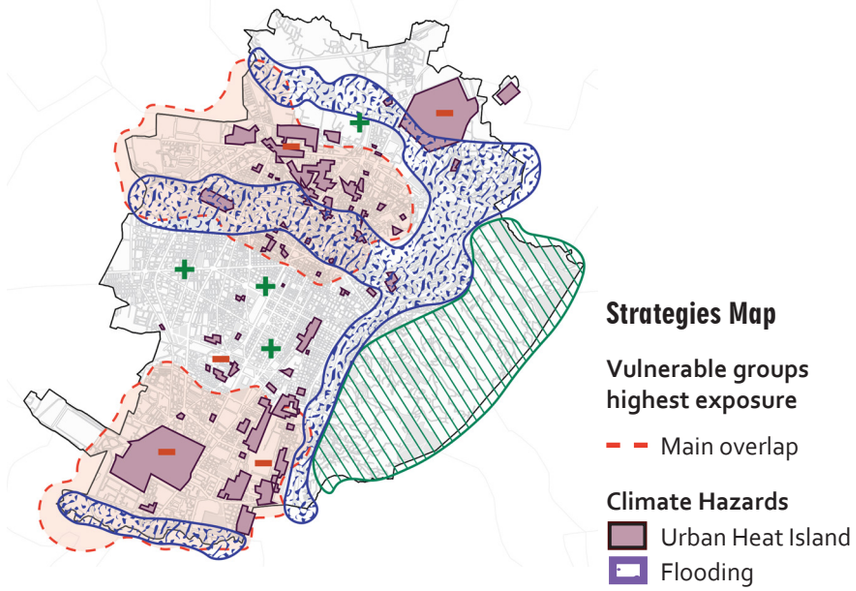
step 2. By 2040 All Kindergarten in Turin and Elementary schools in most vulnerable areas transformed into Urban Climate Shelter

step 3. By 2050 All schools and universities in Turin transformed into Urban Climate Shelter

Goal 2050: Have all schoolyards transformed into Urban Climate Shelter and provide access to a green space for all within 5 min walk

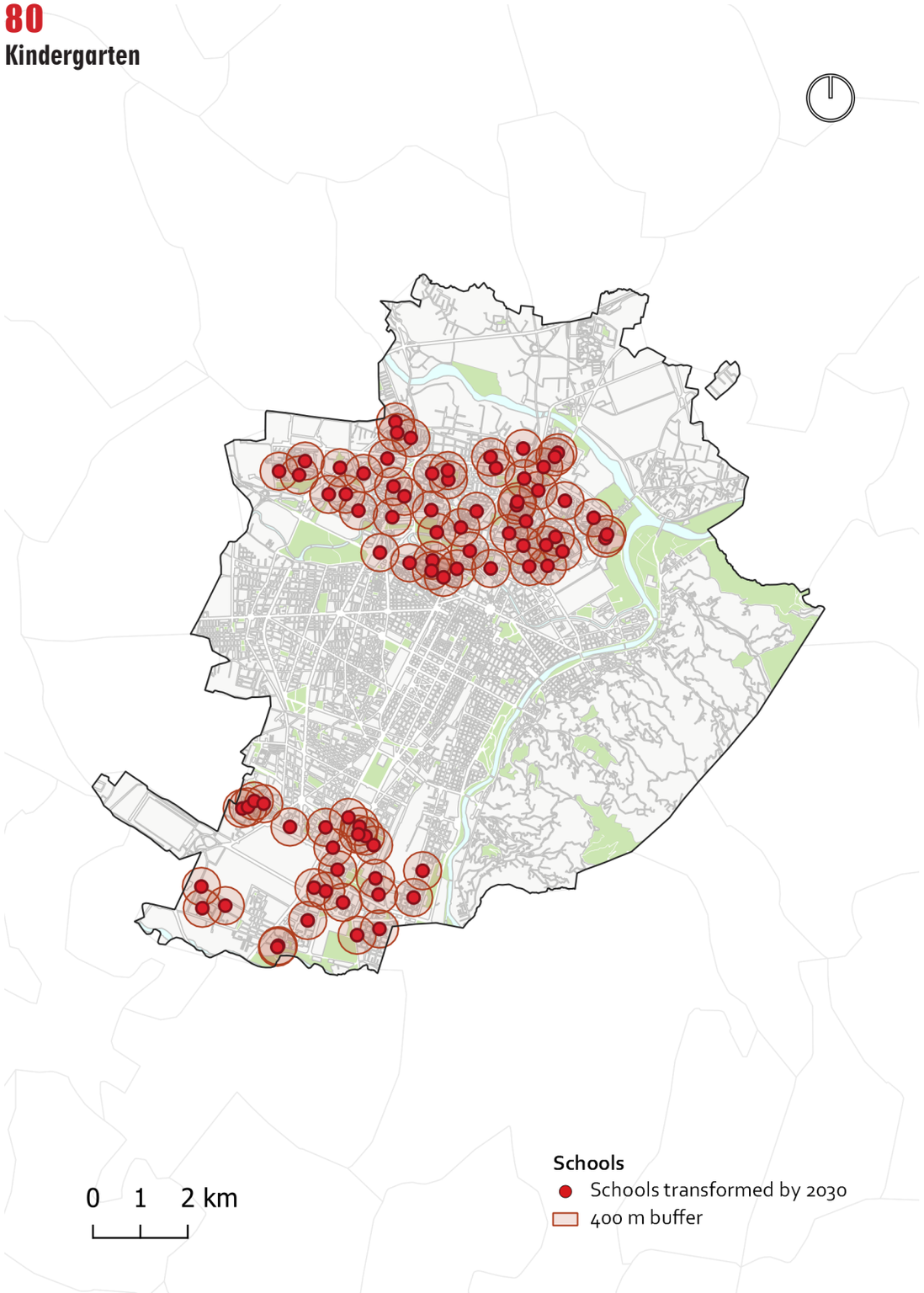
TURIN 2030:

- **2030 Selected Kindergarten in most vulnerable areas transformed into Urban Climate Shelter**



Map 27: Map of intersection of Social Vulnerability and Climate Hazards. Author's elaboration.

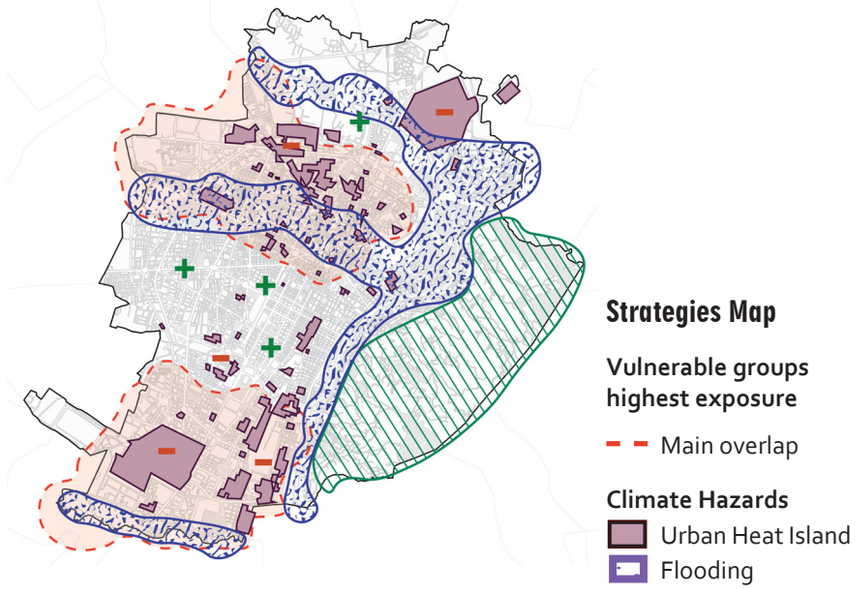
80
Kindergarten



Map 28: Proposal for Turin in 2030. Author's elaboration.

TURIN 2040

- All Kindergarten in Turin
  transformed into Urban Climate Shelter
- 53 Elementary schools in most vulnerable areas
  transformed into Urban Climate Shelter

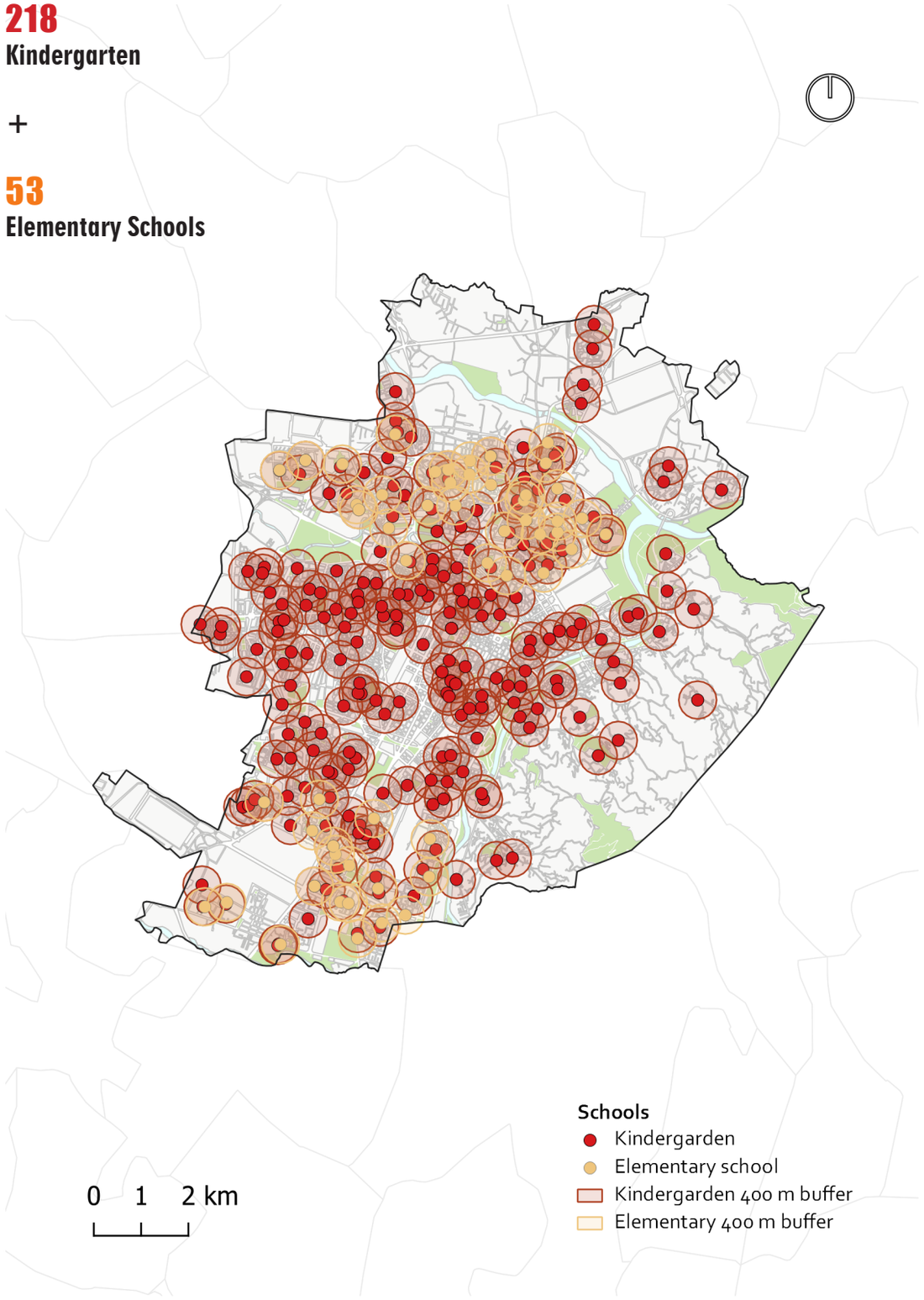


Map 29: Map of intersection of Social Vulnerability and Climate Hazards. Author's elaboration.

218
Kindergarten

+

53
Elementary Schools



Map 30: Proposal for Turin in 2040. Author's elaboration.

TURIN 2050

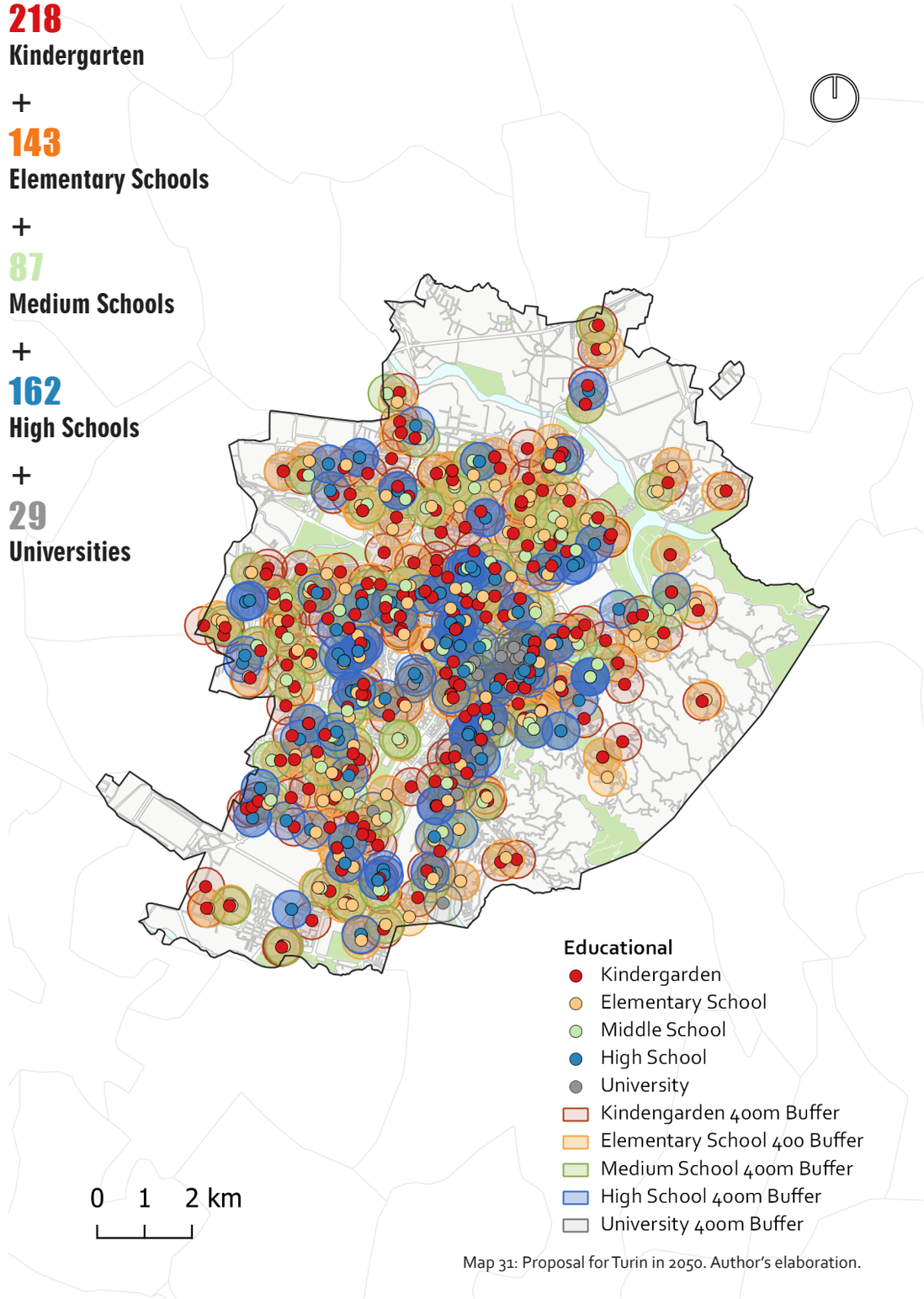
610 schools
transformed into Urban Climate Shelter

29 universities
transformed into Urban Climate Shelter

639 urban spaces
transformed into Urban Climate Shelter

Start transformation beyond schoolyards

218
Kindergarten
+
143
Elementary Schools
+
87
Medium Schools
+
162
High Schools
+
29
Universities



Map 31: Proposal for Turin in 2050. Author's elaboration.

CHAPTER 06.

CONCLUSION

Conclusion

Urban Climate Shelter and

- **European Green Deal**
- **European Climate Pact**
- **Just Green Transition**
- **Turin path within 100 Climate Neutrality Cities EU Mission**
- **Action Plan for a Sustianale and Resilent Turin 2030**
- **Climate Resilient Plan for Turin**
- **Green Infrastructure Strategic Plan in Turin**
- **"Piano Integrato Urbano" 2022**
- **School Squares "Piazze scolastiche"**
- **Open Courtyards "Cortili Aperti"**

Urban Climate Shelter
and the Correlation with European Goals

This master thesis coordinates with numerous goals for achieving more sustainable and resilient cities following the goals set by the international policy circles, such as the UN Sustainable Development Goals, the Paris Agreement, the Sendai Framework for Disaster Risk Reduction, and the New Urban Agenda (HABITAT III). In addition, it correlates with the European Green Deal and European Climate Pact, framing the implementation solutions that cities can use to adapt to climate change (Tollin et al., 2021). Within the European Green Deal, the Nature Restoration Plan aims to assist nature recovery, by reducing soil sealing and urban sprawl, prolonging the efficacy and significance of the natural capital (European Green Deal, 2020). Furthermore, the European Climate Pact ensures that everyone can contribute to making Europe greener, promoting the Sustainable Development Goals, uniting diverse groups such as local communities and schools, and helping transform behavior from a single individual to a bigger scale. In addition, numerous educational programmes in schools - such as Education for Climate Coalition, Blue Schools Network, Commission's Learning Corner, European Youth Portal, and European Competence Framework - provide solutions to encouraging climate awareness and incorporating climate science. Moreover, the research frames with the Just Transition Mechanism, introduced in 2021 with the aim of collaboration for a greener future although putting social and spatial justice into perspective, highlighting the essential role of urban planners in sustainable and inclusive development (Cotella, 2023). In this perspective, UCS can be framed as one codified solution that can contribute to the circular transformation of urban areas facing the main urban challenges posed by the European Green Deal. On this point, UCS advances and facilitates cross-border research and innovation endeavors dedicated to addressing urban challenges and supporting cities as they progress towards a more sustainable, resource-efficient, and streamlined operational paradigm. Moreover, UCS ensures the leverage of evidence-based insights to make European urban environments more sustainable and responsive to climate challenges.

Urban Climate Shelter and the Correlation with Turin's Goals

At the regional level, in the "The Piedmont Region for Green Education" schools are considered as a collaborative project that results from the initiative of making schools more sustainable. According to the Strategic Plan of the Metropolitan City of Turin, the main concern regarding schools and sustainability is the "change of behavior and lifestyle" promoting awareness and sustainable development within communities. Additionally, the plan mentions the use of tools and policies, containing training and education for schools by the responsible public administrations, including the local sector. Nevertheless, these strategies are limited to didactic activities, with no mention of any spatial change in the school environment. Moreover, the City of Turin is highly committed to redesigning schools. In recent years a new project has been emerging, the "school squares", emphasizing the importance of school squares defined as the entrance of the school and proposing the transformation of these spaces. Based on the analysis of schools and Milan and Turin's metropolitan area, the research clarifies the importance of these spaces on the city scale. It suggests that the school entrance could be spaces used not only by the school community but also by other citizens. Furthermore, it provides several possibilities for transformation in the environmental and social scope (Pileri et al., 2022). Additionally, the "Piano Integrato Urbano 2022" envisions the requalification of some school buildings in specific areas of the city, financed by the Italian Plan of Recovery and Resilience. Another project is the Open Courtyards "Cortili Aperti", implemented by the city of Turin in 2013, intending to open the school courtyard to the community after school hours, with a focus on strengthening social cohesion. Since its beginning the project transformed 9 schools and it has been financed episodically. However, the "Open Courtyards" project represents a lack of focus on addressing environmental challenges, as well as providing shelter during most hot days, since it opens from Monday to Friday, from 4:30 pm to 7:00 pm, with closure during the months of July and August (Citta' di Torino, Cortili Aperti). In this perspective, an action that works holistically on open area of the schoolyards and addressing adaptation to climate change are missing. Therefore, UCS can be a solution in this direction because it coordinates with the "school squares" project. The UCS project can enhance the interaction area that is so important for the school community, improve the quality of life for everyday school usage, and provide additional public space for citizens, increasing greenery and adapting to climate change. Transitioning to the climate ambition of the city of Turin, the research aligns with the "Turin path within 100 Climate Neutrality Cities EU Mission", which aims to transform towards climate neutrality by 2030. Turin's vision consists of five strategic actions, including the goal of a more livable, greener, and sustainable community. Furthermore, another addressed topic is the public and private stakeholder engagement, emphasizing citizens as central players and key actors for change (Deambrogio, 2023). It also highlights the involvement of the school community and the young generation. However, considering the project is still in progress, it represents a lack of strategies to engage and involve schools and children. Therefore, the Urban Climate Shelter project provides a valuable addition to the city of Turin, through awareness and community engagement, it not only offers tangible transformations but also several benefits for the population and the environment.

Are Urban Climate Shelters an effective way to resolve the interplay between policy and practice to integrate climate action into planning?

The thesis takes a broader perspective and aims on advocate UCSs to serve as a comprehensive strategy, overcoming the process of transformation only in selected schools. Ultimately, UCSs will provide a codified solution in redesigning schoolyards for cities, generating a wave of transnational cooperation in renovated approaches to revitalizing schoolyards using NBSs. Moreover, UCSs offer promising solutions for solving the interplay between policy and practice to develop planning and design solutions. Considering the effectiveness on the best practices cities analyzed , where bottom-up approaches and initiatives, not bound by policies, have demonstrated success. Given the complexity and uniqueness of each urban area further in-depth research is necessary on the policy implementation of Urban Climate Shelter for every individual area. This research aims to provide one solution for cities potentially that can be applied globally, fostering adaptation to climate change through a co-productive and inclusive process. Addressing the concept of Urban Climate Shelter as a transformation technique from traditionalist to sustainable approaches. Therefore, as stated, the research focused on schoolyards since it provides an efficient starting point, offering awareness to multiple ages groups and enhancing the engagement of various stakeholders. However, the Urban Climate Shelter initiative should go beyond the schoolyard, addressing sectors outside education and extending the transformation to other built environments.

Traditionalist approach to schoolyards

Schoolyards only as a place for educational purposes, with poor choice of materials and unsafe for kids during hot days

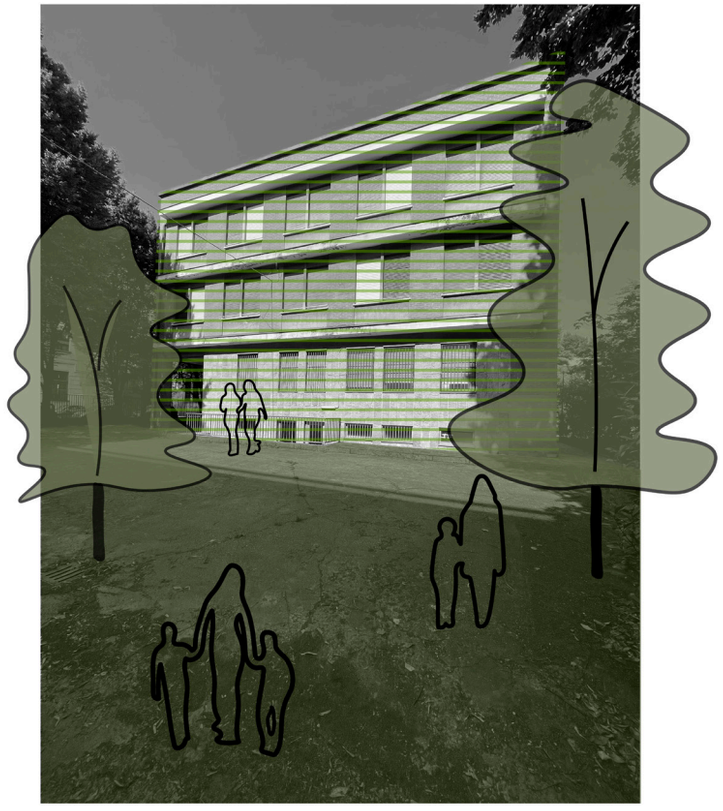
Highly paved area with low-albedo material

Facade that receive direct sun light and lack of trees

Figure 45: Traditionalist approach to schoolyards. Source: Author's elaboration.

Urban Climate Shelter approach to schoolyards

Schoolyards safe for kids to play and as a green space for the whole community, while adapting the city to climate change



Permeable and natural material paving

Higher greenery and shaded areas

Figure 46: Urban Climate Shelter approach to schoolyards. Source: Author's elaboration.

Follow-up of the research

The result of this research can be a starting point for spreading the guidelines and methodology to different cities worldwide, and to enhance the bottom-up approach and initiatives for adapting cities to climate change. Nevertheless, there are many possibilities for the continuation of the research, firstly, to provide a deeper analysis of solutions related to transforming schoolyards beyond the European context, therefore, this approach can make possible higher knowledge and an improvement of the guidelines for Urban Climate Shelter. Secondly, to provide extensive research on participatory processes and alternatives for the engagement of stakeholders and raise awareness in the school environment and community. Furthermore, a holistic understanding of the upscaling process on the pilot case for the city of Turin, comprehending each schoolyard and providing a holistic analysis, throughout a qualitative matter to define which schools are qualified for transformation. Finally, a comprehensive analysis of Italian regulations and extensive approaches such as interviews with authorities and the school community are advised. For future research, a thorough examination of Italian regulations, particularly those within the city of Turin, regarding the transformation of schoolyards and alteration of material types is essential. This investigation should take into account the intricacies of policies and constrains related to school construction regulations , preservation of historical features, and constrains on community use of school facilities.

Final considerations

As I write this master thesis the world's record highest temperatures in history, more and more climate disasters are registered, and Rio do Sul my hometown in Brazil suffers once more from big flood events. I deeply hope this research can make a difference in someone's life and collaborate to be part of the path for a greener, more sustainable, more resilient, and more equal future. I believe that every little action makes a huge difference in the long run, therefore, it is essential to spread awareness related to climate change and the incentive to each person to collaborate with this race and to take care of our planet for future generations. Additionally, I hope that this research will pave the way for many other initiatives to succeed since I firmly believe that Urban Climate Shelters have plenty of strengths. Furthermore, I would like to point out that there are many different steps that cities can take to move toward a sustainable and resilient future rather than just one ideal course of action. One solution cannot address all of the climate challenges, much as one Urban Climate Shelter cannot make an impact on a city's size and the upscaling and replication component is therefore indispensable.

Internship Abroad

Southern University of Denmark (SDU)
From April to July 2023

- Research project on Urban Climate Shelter
- Part of the development of classes for the Bachelor's course in Sustainable Urban Development
- Member of the organization committee of Urban Resilience Intensive Training 2023
- Participant of Urban Resilience Intensive Training 2023

Outcomes of the research

Award

13 October 2023 - Politecnico di Torino
Best poster award at Climate Action -– Adaptation Event for the poster "Urban Climate Shelter. A blueprint of action for cities to adapt climate change" (O. Caldarice**, B. Pincegher,** N. Tollin**,** M. Pizzorni)
https://www.polito.it/ateneo/comunicazione-e-ufficio-stampa/poliflash/le-azioni-del-politecnico-per-la-crisi-climatica

Conferences

24 October 2023 - Università di Genova
Selected speaker with the presentation "Urban Climate Shelters to Adapt Cities to Climate Change. A Proposal for Schoolyards in Turin (Italy)" at the Symposium: [DES]IGNING [RES]ILIENCE strategies for the sustainable development of cities and understanding of urban complexity (**B. Pincegher,** M. Pizzorni**,** O. Caldarice**,** N. Tollin)

Publications

Caldarice, O., **Pincegher, B.,** Pizzorni, M., Tollin, N. (2023, accepted for publication). "Urban Climate Shelters to Adapt Cities to Climate Change. A Proposal for Schoolyards in Turin (Italy)". Genoa University Press (GUP).

Caldarice, O., **Pincegher, B**., Pizzorni, M., Tollin, N. (2024, accepted for publication). "Urban Climate Shelters: a nature-based solution for urban resilience". In Firoz.C, M., Dashora, L. K., Shaw, R. (eds., 2024), "Nature-Based Solutions for Urban and Peri-Urban Areas for resilient and sustainable urbanization". Springer publisher, Cham.

European Proposal

Member of the research group for the pre-proposal submission to the Driving Urban Transformations (DUT) Call for Proposals 2023 with the project "MAINCODE – MAINstreaming nature to CO-Design urban climate shelters in schoolyards" – Politecnico di Torino, Southern University of Denmark, Urban Lab Torino, Commonspace srl, City of Turin, City of Halandri (coordinator: O. Caldarice, Politecnico di Torino).

GLOSSARY

Climate shelter/refuges: climate shelter is defined as a natural space where animals use to hide from the weather events. However, in the spatial planning context climate shelter is a new term used by the city of Barcelona to refer to a cooling public space that provides thermal comfort for residents and tourists (Vetter, 2020).

School surroundings / Healthy school environments / Caring for public spaces in schools: A term used by the city of Madrid, it refers to adaptation measurements for climate change, by transforming schools' immediate, proximate surroundings as well as the schoolyard (De Madrid et al., 2016; Serrano et al., 2017; Vetter, 2020).

Climate Resilient Schools: Terminology defined by the city of London to describe the project of adapting schools to the impacts of climate change ("Climate resilient schools", 2023).

School oasis: Defined by the city of Paris school oasis is a concept defined as the idea of a cool island by adapting to climate change through school-based initiatives (Sitzoglou, 2020).

Greening school playgrounds in Amsterdam / Amsterdam Impulse Schoolyards (AIS): A public initiative by the municipality of Amsterdam to transform the playgrounds of the primary schools across the city (Disch EDisch & Projectmanager AIS, 2018).

Green School Squares: terminology used by The Hague with the aim to proportionate easier access to nature to the children living in urban area ("Developing cooler, greener schoolyards across the city"; "Schoolyard the Hague").

URBAN CLIMATE SHELTER (UCS): considering that climate shelter has its roots in a natural context, in this research the terminology used to define the phenomenon will be Urban Climate Shelter, which includes the natural principle of a climate shelter but is implemented in an urban context. URBAN CLIMATE SHELTER (UCS) can be defined as a space that provides features for the adaptation to climate change, providing security from the heat, precipitation, and droughts, and so on, through a multi-hazard approach by using green and blue infrastructures. Moreover, along the process of co-production of local stakeholders, enhancing awareness of climate challenges.

ESSENTIAL REFERENCES

Amoly, E., Dadvand, P., Forns, J., López-Vicente, M., Basagaña, X., Julvez, J., Alvarez-Pedrerol, M., Nieuwenhuijsen, M. J., & Sunyer, J. (2015). Green and blue spaces and behavioral development in barcelona schoolchildren: The BREATHE project. Environmental Health Perspectives, 122(12), 1351–1358. https://doi.org/10.1289/ehp.1408215

Antoniadis, D., Katsoulas, N., & Papanastasiou, D. (2020). Thermal environment of urban schoolyards: Current and future design with respect to children's thermal comfort. In Atmosphere (Vol. 11, Issue 11). MDPI AG. https://doi.org/10.3390/atmos11111144

Barcelona: a city in climate action. Retrieved July 19, 2023, from https://uia-initiative.eu/en/news/barcelona-city-climate-action

Barcelona's Climate Action Plan 2018 - 2030. (2018).

Barcelona's pilot project to beat the heat. https://uia-initiative.eu/en/news/barcelonas-pilot-project-beat-heat-0

Baró, F., Camacho, D. A., Perez del Pulgar, C., Ruiz-Mallén, I., & García-Serrano, P. (2022). Nature-Based Climate Solutions in European Schools: A Pioneering Co-designed Strategy Towards Urban Resilience. In Urban Book Series (pp. 125–146). Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1007/978-3-031-07301-4_6

Baró, F., Camacho, D. A., Pérez Del Pulgar, C., Triguero-Mas, M., & Anguelovski, I. (2021). School greening: Right or privilege? Examining urban nature within and around primary schools through an equity lens. Landscape and Urban Planning, 208. https://doi.org/10.1016/j.landurbplan.2020.104019

Bragaglia, F., Caldarice, O., & Janin Rivolin, U. (2023). Outside-in: Co-production and the spatial planning systems in Italy and England. Planning Theory. https://doi.org/10.1177/14730952231203516

Brunetta, G., Ceravolo, R., Barbieri, C. A., Borghini, A., de Carlo, F., Mela, A., Beltramo, S., Longhi, A., De Lucia, G., Ferraris, S., Pezzoli, A., Quagliolo, C., Salata, S., & Voghera, A. (2019). Territorial resilience: Toward a proactive meaning for spatial planning. Sustainability (Switzerland), 11(8). https://doi.org/10.3390/su11082286

Caldarice, O., Tollin, N., & Pizzorni, M. (2021). The relevance of science-policy-practice dialogue. Exploring the urban climate resilience governance in Italy. City, Territory and Architecture, 8(1). https://doi.org/10.1186/s40410-021-00137-y

Canicule : toutes les infos - Ville de Paris. https://www.paris.fr/pages/la-canicule-5469#la-carte-des-ilots-et-parcours-de-fraicheur

Cartalis, C. (2020a). The Climate Shelters project Journal N° 1.

Cartalis, C. (2020b). The Climate Shelters project Journal N° 2 CLIMATE ADAPTATION.

Cartallis, Constantinos., 2020. Science in the City. https://uia-initiative.eu/en/news/science-city

Caue De Paris, ©. PROJECT DETAILS A NEW WAY TO RENOVE SCHOOLYARDS.

Città di Torino. (2022). Piano Integrato Urbano. http://www.comune.torino.it/cittagora/wp-content/uploads/2022/11/PianiIntegratiUrbani.pdf

CLIMATE RESILIENCE PLAN. (2020). www.comune.torino.it/ambiente

CORTILI SCOLASTICI APERTI. Citta' di Torino. http://www.comune.torino.it/iter/progetti/laboratorio-citta-sostenibile/cortili-aperti/

Cortili Scolastici Aperti. Torino Bimbi. https://www.torinobimbi.it/notizie/cortili-scolastici-aperti.html

CO-CONCEPTION DU PROJET DE TRANSFORMATION DE L'ÉCOLE ÉLÉMENTAIRE JEANNE D'ARC.

Cours Oasis Jean Dolent. https://sites.google.com/caue75.fr/coursoasisjeandolent/accueil

Cours Oasis Jeanne d'Arc. (a). https://sites.google.com/caue75.fr/coursoasisjeannedarc/accueil

Cours Oasis Jeanne d'Arc. (b). https://sites.google.com/caue75.fr/coursoasisjeannedarc/accueil

Cultivating a School Culture for Climate Action - The Barcelona example. https://uia-initiative.eu/en/news/cultivating-school-culture-climate-action-barcelona-example

Davoudi, S. (2014). Climate change, securitisation of nature, and resilient urbanism. Environment and Planning C: Government and Policy, 32(2), 360–375. https://doi.org/10.1068/c12269

Davoudi, S., Shaw, K., Haider, L. J., Quinlan, A. E., Peterson, G. D., Wilkinson, C., Fünfgeld, H., McEvoy, D., & Porter, L. (2012). Resilience: A Bridging Concept or a Dead End? "Reframing" Resilience: Challenges for Planning Theory and Practice Interacting Traps: Resilience Assessment of a Pasture Management System in Northern Afghanistan Urban Resilience: What Does it Mean in Planning Practice? Resilience as a Useful Concept for Climate Change Adaptation? The Politics of Resilience for Planning: A Cautionary Note. In Planning Theory and Practice (Vol. 13, Issue 2, pp. 299–333). Routledge. https://doi.org/10.1080/14649357.2012.677124

De Madrid, A., Serrano, P. G., Leal, P., Lucila, L., Peña, U., Hernández, C., Colaborador, V., & Moreno, M. B. (2016). PROYECTO MICOS. ENTORNOS ESCOLARES SALUDABLES.

Developing cooler, greener schoolyards across the city | Resilient City Den Haag. Retrieved July 19, 2023, from https://resilientthehague.nl/en/projects/koelere-en-groenere-schoolpleinen-in-de-stad/

Disch EDisch, E., & Projectmanager AIS, amsterdamnl. (2018). Greening school playgrounds in Amsterdam Amsterdam Impulse School playgrounds (AIS). https://maps.amsterdam.nl/koers/?LANG=en

Ellena, M., Melis, G., Zengarini, N., Di Gangi, E., Ricciardi, G., Mercogliano, P., & Costa, G. (2023). Micro-scale UHI risk assessment on the heat-health nexus within cities by looking at socio-economic factors and built environment characteristics: The Turin case study (Italy). Urban Climate, 49. https://doi.org/10.1016/j.uclim.2023.101514

École élémentaire JEANNE D'ARC. https://www.caue75.fr/ateliers-a-l-ecole/ateliers-cours-oasis/les-etablissements-accompagnes-par-le-caue-de-paris/ecole-elementaire-jeanne-darc

École maternelle JEAN DOLENT. https://www.caue75.fr/ateliers-a-l-ecole/ateliers-cours-oasis/les-etablissements-accompagnes-par-le-caue-de-paris/ecole-maternelle-jean-dolent

Fares, A., Habibi, H., & Awal, R. (2021). Front Matter. In Climate Change and Extreme Events (pp. i–ii). Elsevier. https://doi.org/10.1016/b978-0-12-822700-8.09991-1

Figueiredo, A., Connor, B., Knight, R., Guida, K., & Bicknell, D. (2020). How London Schools and Early Years Settings can Adapt to Climate Change. www.london.gov.uk

Filho, W. L. (2020). Encyclopedia of the UN Sustainable Development Goals Series Editor. https://doi.org/10.1007/978-3-319-95717-3

Flax, L., Korthals Altes, R., Kupers, R., & Mons, B. (2020). Greening schoolyards - An urban resilience perspective. Cities, 106. https://doi.org/10.1016/j.cities.2020.102890

GBG_AS2C - Blue, Green & Grey_Adapting Schools to Climate Change | UIA - Urban Innovative Actions. https://www.uia-initiative.eu/en/uia-cities/barcelona-call3

Giezen, M., & Pellerey, V. (2021). Renaturing the city: Factors contributing to upscaling green schoolyards in Amsterdam and The Hague. Urban Forestry and Urban Greening, 63. https://doi.org/10.1016/j.ufug.2021.127190

Indicators as tools for Adaptation to Climate Change at the city scale - The Climate Shelters project of the City of Barcelona. https://uia-initiative.eu/en/news/indicators-tools-adaptation-climate-change-city-scale-climate-shelters-project-city-barcelona

IPCC, 2023: Summary for Policymakers. In: Climate Change 2023: Synthesis Report. A Report of the Intergovernmental Panel on Climate Change. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, 36 pages. (in press). Indicatore socioeconomico della città di Torino. Geoportale. http://geoportale.comune.torino.it/web/node/2211

Kuo, M., Klein, S. E., HEM Browning, M., & Zaplatosch, J. (2021). Greening for academic achievement: Prioritizing what to plant and where. Landscape and Urban Planning, 206. https://doi.org/10.1016/j.landurbplan.2020.103962

Les cours Oasis - Ville de Paris. Retrieved July 19, 2023, from https://www.paris.fr/pages/les-cours-oasis-7389/

Lin, B. B., Ossola, A., Alberti, M., Andersson, E., Bai, X., Dobbs, C., Elmqvist, T., Evans, K. L., Frantzeskaki, N., Fuller, R. A., Gaston, K. J., Haase, D., Jim, C.Y., Konijnendijk, C., Nagendra, H., Niemelä, J., McPhearson, T., Moomaw, W. R., Parnell, S., … Tan, P. Y. (2021). Integrating solutions to adapt cities for climate change. In The Lancet Planetary Health (Vol. 5, Issue 7, pp. e479–e486). Elsevier B.V. https://doi.org/10.1016/S2542-5196(21)00135-2

Maintenance guide OASIS SCHOOLYARDS-MAINTENANCE GUIDE 2. https://climate-adapt.eea.europa.eu/en/metadata/case-studies/paris-oasis-schoolyard-programme-france/maintenance-guide_eng_final.pdf

Making Cities Sustainable and Resilient Campaign: implementing the Sendai Framework for Disaster Risk Reduction 2015 – 2030 at the local level. https://sdgs.un.org/partnerships/making-cities-sustainable-and-resilient-campaign-implementing-sendai-framework

Meerow, S. A., & Baud, I. (2012). Generating resilience: Exploring the contribution of the small power producer and very small power producer programs to the resilience of Thailand's power sector. International Journal of Urban Sustainable Development, 4(1), 20–38. https://doi.org/10.1080/19463138.2012.667414

Meerow, S., & Newell, J. P. (2019a). Urban resilience for whom, what, when, where, and why? Urban Geography, 40(3), 309–329. https://doi.org/10.1080/02723638.2016.1206395

Meerow, S., & Newell, J. P. (2019b). Urban resilience for whom, what, when, where, and why? Urban Geography, 40(3), 309–329. https://doi.org/10.1080/02723638.2016.1206395

Meerow, S., Newell, J. P., & Stults, M. (2016). Defining urban resilience: A review. In Landscape and Urban Planning (Vol. 147, pp. 38–49). Elsevier B.V. https://doi.org/10.1016/j.landurbplan.2015.11.011

Mitlin, D. (2008). With and beyond the state - Co-production as a route to political influence, power and transformation for grassroots organizations. In Environment and Urbanization (Vol. 20, Issue 2, pp. 339–360). https://doi.org/10.1177/0956247808096117

OASIS - School yards: Openness, Adaptation, Sensitisation, Innovation and Social ties: Design and transformation of local urban areas adapted to climate change, working jointly with users | UIA - Urban Innovative Actions. https://uia-initiative.eu/en/uia-cities/paris-call3

Orsetti, E., Tollin, N., Lehmann, M., Valderrama, V. A., & Morató, J. (2022). Building Resilient Cities: Climate Change and Health Interlinkages in the Planning of Public Spaces. International Journal of Environmental Research and Public Health, 19(3). https://doi.org/10.3390/ijerph19031355

Paolo Pileri, Cristina Renzoni, & Paola Savoldi. (2022). School Squares - Reinventing the dialogue between school and city. Esperia.

PIANO STRATEGICO DELL'INFRASTRUTTURA VERDE. (2020). www.comune.torino.it/verdepubblico

Progetto "Cortili Aperti". Citta' di Torino. (2016). http://www.comune.torino.it/circ7/cm/pages/ServeBLOB.php/L/IT/IDPagina/3950

Project Refugis Climàtics. https://bcnroc.ajuntament.barcelona.cat/jspui/bitstream/11703/127541/1/Informe_BonaPractica_RefugisClimatics.pdf

Raymond, C. M., Frantzeskaki, N., Kabisch, N., Berry, P., Breil, M., Nita, M. R., Geneletti, D., & Calfapietra, C. (2017). A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. Environmental Science and Policy, 77, 15–24. https://doi.org/10.1016/j.envsci.2017.07.008

Serrano, G. P., Laredo, L. P., & Pena, U. L. (2017). GUÍA DE DISEÑO DE ENTORNOS ESCOLARES. https://www.madridsalud.es/pdf/guia_diseno_entornos_escolares_opt.pdf

Sitzoglou, M. (2020). The OASIS Schoolyards project Journal N° 1. https://www.uia-initiative.eu/sites/default/files/2020-06/Paris_OASIS_Journal.pdf

Tollin, N., Wieszczeczynska, K. A., Pizzorni, M., Caldarice, O., Brunetta, G., & Morato, J. (2021). Tools and networks for local climate action: a stocktaking. United Nations Office for Disaster Risk Reduction (UNDRR).
Ufficio di stastitica. Citta' di Torino. Struttura della popolazione per età annuale e circoscrizione. http://www.comune.torino.it/statistica/dati/demog.htm

United Nations. Department of Economic and Social Affairs. (2020). World Social Report 2020 : inequality in a rapidly changing world.

United Nations Office for Disaster Risk Reduction. (2017). DETAILED LEVEL ASSESSMENT DISASTER RESILIENCE SCORECARD FOR CITIES.

United Nations Office for Disaster Risk Reduction. (2017). DISASTER SCORECARD RESILIENCE FOR CITIES.

Upscaling with a vision - The school yard as a school. https://uia-initiative.eu/en/news/upscaling-vision-school-yard-school

Vetter, R. (2020). COOLING SCHOOLS EXPERIENCES FROM C40'S COOL CITIES NETWORK. Retrieved July 18, 2023, from https://c40.my.salesforce.com/sfc/p/#36000001Enhz/a/1Q000000gSgu/hzEXMYnfgVY5x4YuMULBTXWcdLg49CUyW8VR59fsrrY

Wahlström, M. (2015). Sendai Framework for Disaster Risk Reduction 2015 - 2030.

World Wild Life. (2021). URBAN NATURE BASED SOLUTIONS CITIES LEADING THE WAY 2021. https://wwfint.awsassets.panda.org/downloads/exe_wwf_a4_template_sbn_final2.pdf

ACKNOWLEDGMENTS

In the middle of a world filled with chaos, I am profoundly grateful for the incredible people who have crossed my path. Foremost, my deep appreciation goes to my parents, Inês and Max. They have always stood by my side, providing a solid foundation for life and solid support for every brave decision I've made. Without their presence, I would not be standing where I am today. I love you with all my heart. To Dani, Talita, and Vivi, my best friends for more than 20 years: you are the sisters I never had. Thank you for always believing in me and for your beyond-positive outlook on my future. Even though we are far apart, we are always together, no matter where, how, why, or when.

- Mãe e Pai, obrigada por todo o amor e apoio que vocês me dão e por sempre estarem ao meu lado. Obrigada por proporcionarem uma base forte, por me apoiarem mesmo nas minhas ideias mais loucas. Sem tudo isso, eu não estaria onde estou hoje. Eu amo vocês. À Dani, Talita e Vivi, minhas melhores amigas há mais de 20 anos: vocês são as irmãs que nunca tive. Obrigado por sempre acreditar em mim e por sua visão mais que positiva sobre meu futuro. Mesmo estando distantes, estamos sempre juntas, não importa onde, como, por que ou quando.-

Additionally, I sincerely thank my supervisor, Ombretta Caldarice, whose belief in me from the beginning of the course provided a driving force. Thank you for entrusting me with captivating projects and guiding me through the intricacies of my thesis. I am also grateful to my co-supervisor, Nicola Tollin, for the invaluable opportunities and knowledge acquired under your guidance. A special acknowledgment is reserved for Maria, whose assistance and supervision went above and beyond the call of duty. Finally, I express my gratitude to sweet JB, with whom I found a shelter of my own, for being by my side on this path, and for cheering me up. Thank you for being a source of comfort and joy that has brightened my way. Last but certainly not least, my gratitude to all my friends who have shared this journey with me. Through the highs and lows, your company has added so much happiness to the experience, making every moment more meaningful.

THANK YOU

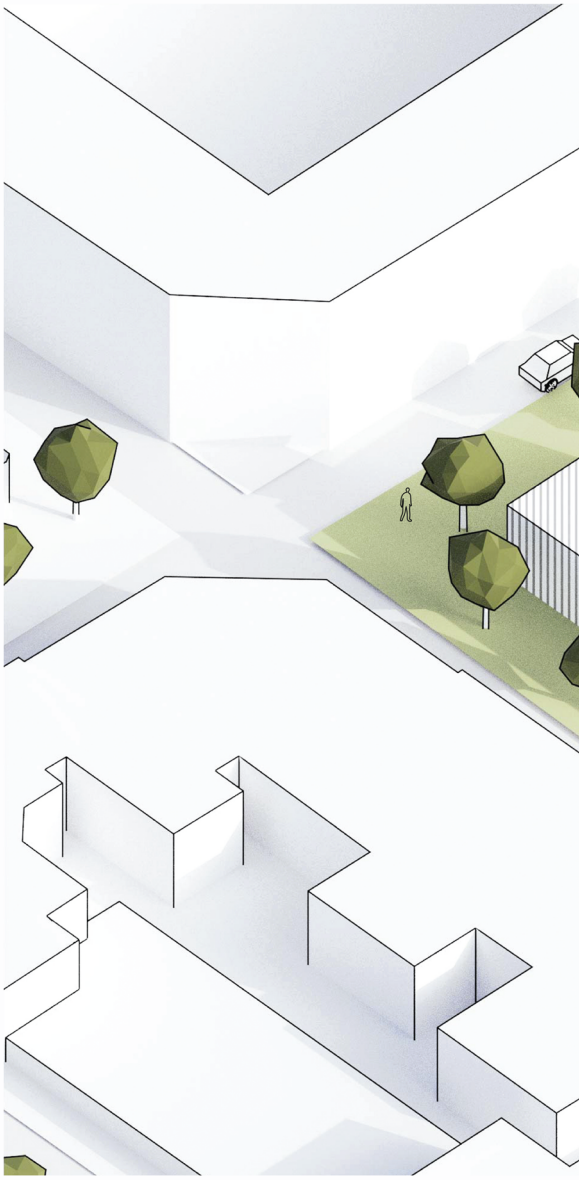
OBRIGADA

GRAZIE

Bruna Pincegher

2023

The thesis "Urban Climate Shelter to adapt cities to climate change. A strategy for re-designing schoolyards in Turin (Italy)" explores how cities can adapt to climate change by transforming urban spaces to cope with climate hazards, specifically by understanding if Urban Climate Shelters are an effective way to resolve the intricate interplay between policy and practice. The concept of Urban Climate Shelter (UCS) is defined as a space that provides features for the adaptation to climate change, fostering security from the heat, flood, and droughts, through a multi-hazard approach by using green and blue infrastructures, together with the process of co-design with local stakeholder. The study establishes six guidelines for successful implementation of UCS. The guidelines were tested on a pilot case, in Turin, Italy, a city characterized by highly impervious and prone to climatic hazards such as heat waves and flooding. Concluding, the recommendations state that starting the transformation by schools is a preliminary pilot since it involves numerous key stakeholders and provides awareness of climate change from an early age. However, the upscaling process should go beyond schoolyards involving other sectors and facilities, subsequently fostering resilient and shelter cities.



BRUNA PINCEGHER 2023