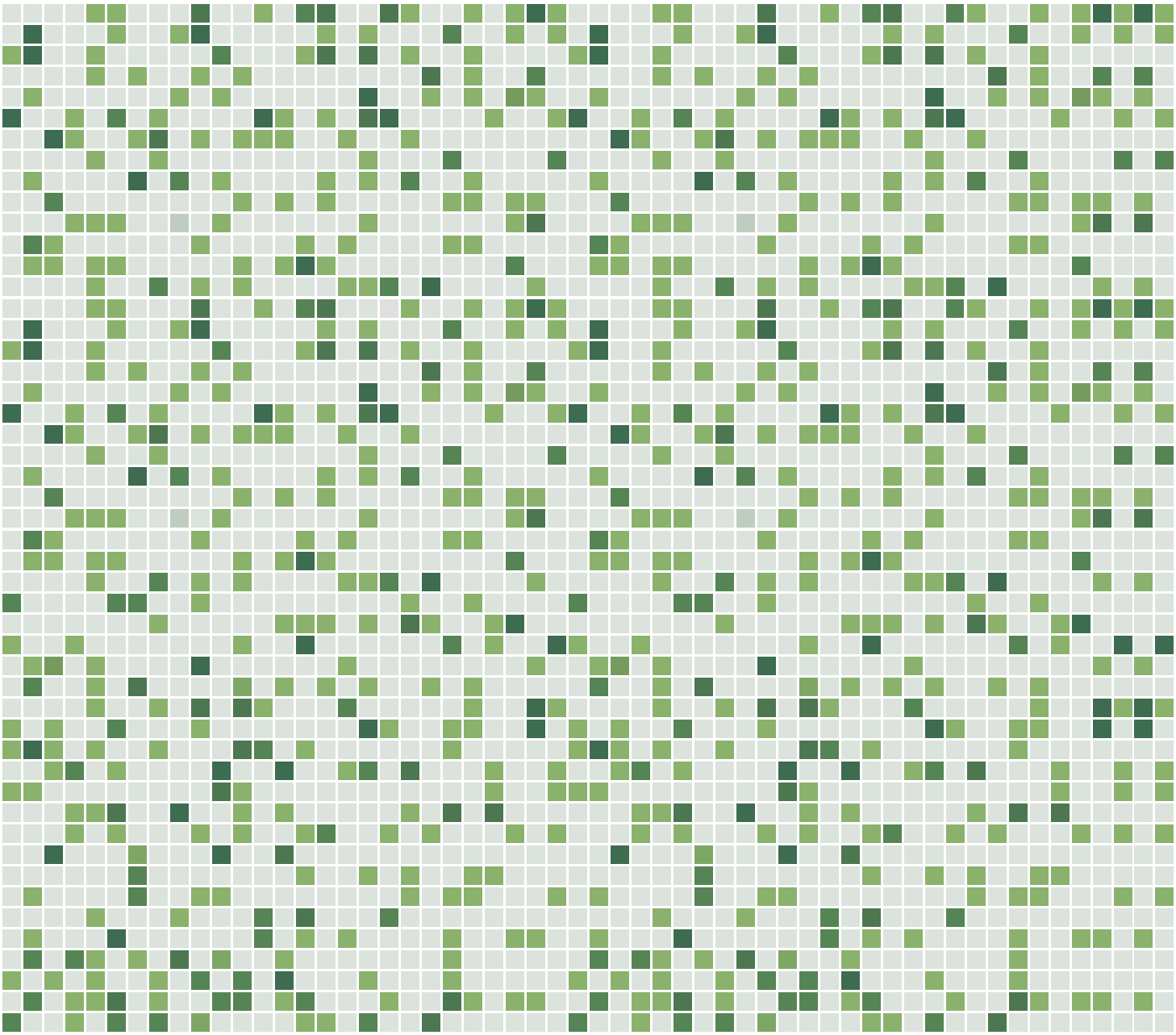
NISHITH JARIWALA

RETHINKING URBAN PUBLIC SPACES FOR CLIMATE CHANGE

Adaptation strategies for Surat (India)



Politecnico di Torino

M.Sc. in Territorial, Urban, Environemtnal and Landscape Planning
A.Y. 2022 / 2023

Master thesis

RETHINKING PUBLIC SPACES FOR CLIMATE CHANGE

Adaptation strategies for Surat (India)

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Prof. Ombretta Caldarice

December 2023

This is a green message.*

* The planet needs you, Please respond!

Source- Smith, K. (n.d.). green_message. Flickr. https://www.flickr.com/photos/kerismith/3573442281/

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// ABSTRACT

Undoubtedly, cities and their population are expanding and growing worldwide, exacerbating the vulnerability of these urban centers to the amplified effects of climate change. In this epoch of rapid urbanization in which urban growth is inevitable, there is a need to create balance in the urban environment where people and nature can co-exist. Cities are key which produce the challenges but at the same time, they also concentrate on grasping the opportunities to deal with these present issues. Nevertheless, urban planning plays a significant role in addressing climate change effects and adapting cities by implementing various strategic planning actions and measures towards carbon neutrality as well as supporting collaborations among different stakeholders, aiming towards more sustainable and resilient cities. To deal with these topics, it is necessary to start looking at the micro-urban scale, which can have a significant impact on the larger scales.

The present thesis aims to discuss how urban public spaces can play a significant role in the urban environment in supporting cities to adapt to climate change. Redesigning public spaces under the lens of climate change at the local scale will help address more significant global issues. Fostering downscaling from a global scale to urban areas can help bring about larger positive changes. Applying this concept to rethink the public spaces to deal with climate change will lead to global sustainability and to the transition to a greener city. To frame how urban planning can be successfully implemented in the designing of public spaces, different successful case studies of urban public spaces from different contexts of the world are studied, specifically, 44 projects of effectively designed

public spaces from various cities of Europe, Asia-Pacific, North/Latin America, and the Middle East. Further, these case studies were analyzed with the help of a comparison matrix through different criteria (Including the year of construction, geographical location, the spatial scale of the project, types of climate impact addressed as well as their methodologies). The research was also made on the primary types of climate impact being addressed in these projects and main climate impacts focused on current trends of planning were identified (Namely (I) Thermal comfort, (II) UHI Mitigation, and (III) Stormwater Management), along with detailed analysis of 5 case studies having different context, scale, and the issues addressed, to recognize and extracting important design strategies to deal with these issues. As a part of the design proposal, the city of Surat located on the western coast of India was analyzed based on its ongoing climatic issues and current climate change adaptation practices. Finally, some public spaces were identified to be studied and to examine their vulnerability and exposure towards different impacts of climate change. To conclude, the knowledge acquired from the theories and case-studies of the research are applied to redesign the identified public spaces in the city to activate it for the climate change supporting the Surat city to adapt to climate change effects and make it more sustainable and resilient.

PART I

THEORETICAL FRAMEWORK

CHAPTER

01

INTRODUCTION

1.1.

Introduction | Background

Fig 1. Crowded Mumbai station
Has Mumbai become India's most unliveable city? (2017, October 2). BBC News. Retrieved November 26, 2023, from https://www.bbc.com/news/world-asia-india-41464636

Fig 2. Roads with traffic
Vaughan, A. (2021, August 25). India unveils climate change plan. The Guardian. https://www.theguardian.com/world/2015/oct/02/India-pledges-40-per-cent-electricity-renewables-2030

Evidently, the current trend of urbanization is making cities across the world grow randomly, attracting higher number of populations towards the urban areas, consequently, making them more exposed to the effects of climate change. According to the UN, more than 50% of the world's population currently live in cities, with a growing global population of 7.8 billion in the year of 2020 (World Cities Report, 2022), making urban centers more responsible for the exceeding carbon emissions and escalating the drastic climate impacts. Nowadays, in order to counteract these threats posed on the sustainable urban development, numerous cities across the world have made several initiatives to increase the resilience, giving more attention toward climate change adaptation, to address the intensifying climate-related risks through effective urban planning policies and strategies (UNFCCC, 2017). The concept of climate change adaptation started to gain more debate after the definition by The Intergovernmental Panel on Climate Change (IPCC), which currently in the Sixth Assessment Report is described as "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities." (Calvin et al., 2023, p. 4). According to the IPCC report, adaptation planning and its implementation has made significant increase throughout all sectors and regions, resulting in positive benefits and effectiveness. However, adaptation gaps still remain regardless of this progress and it will continue to cultivate due to current degree of implementation in making urban planning more focus towards climate change adaptation and building resilience of the cities across the globe (Romero et al., 2023).

1.2.

Introduction | Problem Statement

Notably, with maximum account of CO2 emissions from worldwide energy usage, the urban areas are substantial contributors to climate change (UN-Habitat | Concept Note, 2021), increasing the frequency of heavy rainfall and storm surges in the densely populated cities, devouring of arable land required for the survival of growing urban population due to desertification as well as the sea-level rise threatening the lives of coastal population (Graça et al., 2022). Regardless of these hazards, multiple cities have been ineffective in adapting to the climate change, due to many factors including related to inadequacy of the urban planning policies and climate action plan which are not yet fully addressing the adaptation towards climate change in order to counteract the impacts (Climate Change | UN-Habitat, 2022). Additionally, the local governments are more responsible in adapting the cities to climate change (Nalau et al., 2015), since the impacts varies according to the different scale of cities across the globe (Crabbé & Robin, 2006; Liu & Fan, 2023). The preparations of climate adaptation and mitigation plans, land use and regulations, and disaster risk management plans as well as the infrastructure network plans of cities across the globe are essential in adapting these cities to climate change (Vogel & Henstra, 2015), which is not yet fully anchored towards dealing with the impacts related to climate change. Moreover, increased focus on the small scale at the city level, specifically in redesigning the public spaces that exist as an integral part of the cities, towards combating the impacts of climate change will help in having more positive effects on larger scale as result of their combination, which needs to be addressed in the current trend of urban planning policies and climate action plans, considering expected future impacts of the climate change with respect to the specific context. This thesis outlines on how at local-scale, public spaces play a vital role acting as a generator of prosperous cities, integrating physical and natural environment and further define the cultural, social, economic, and political functions of cities, however, their value remains neglected by most of the urban policy makers (Global public space programme, 2021).

Fig 3. Climate change poster
Grantham, J. "Climate change protest sign" by Stocksy Contributor "Jen Grantham." Stocksy United. Retrieved November 27, 2023, from https://www.stocksy.com/2768234/climate-change-protest-sign

1.3.

With the aim of integrating climate change adaptation into urban planning by focusing on small-scale existing urban public spaces, the present thesis revolves around the central question of:

“How redesigning existing public spaces in an urban area will help in adapting cities faster to the effects of climate change?”

Therefore, public spaces, which are an integral part of an urban area and playing an important role in the cities, can be redesigned to tackle with the issues of climate change based on context specific impacts that cities will have on them in order to adapt them faster towards climate change and further having positive benefits on the larger scale. Subsequently, the following sub-questions were addressed to support the principal concept of the thesis:

Introduction | Research Question

1. **How currently public spaces are being design in cities across the globe to deal with the issues related to climate change and are they a part of urban planning policies?**

2. **What are the main impacts that are being address in the current trend of urban planning along with their methodologies and outputs?**

3. **What are the important design strategies that can help in activating public spaces for the climate change?**

4. **How different small-scale public spaces can create a green network of systems to create more sustainable and resilient cities for the future?**

5. **Will this integration about small intervention of activating public spaces for climate change in the urban planning policies at local scale will help in creating benefit at national and global level?**

1.4. Introduction | Hypothesis

The research validates the idea of focusing on the multiple small-scale intervention in an urban area with the help of urban planning policies, in order to solve the impacts of climate change. Specifically, through innovative design-based approach towards the urban public spaces can help in mitigating and adapting the severe impacts of Urban Heat Island effect, storm-water and thermal discomfort. Further, public spaces can provide a network of green spaces, transitioning the cities towards the concept of carbon-neutrality and climate resilience. Eventually, addressing these issues at the core of the city in thick of existing public spaces with a better designed module will have a larger positive effect on the national and at the end the global level.

Fig 4. Abstract map of Surat (India) - Author's elaboration

1.5.

Introduction | Research Objectives

This thesis intent to identify and evaluate the current vulnerabilities of the urban areas to climate change effects and further aims to derive the potential of public spaces that can serve as a significant contributor to climate change adaptation strategies. Furthermore, it involves understanding different case-studies of resilient public spaces around the world in order to assess their effectiveness in the design intervention and strategies aimed at adapting them towards climate change effects. However, it also involves the side of policies inclined towards inclusive and participatory planning and design process, as the public spaces should consider social equity in the path towards sustainability and resilience. Finally, thesis aspire to suggest the framework for practitioners and policymakers in regards of the redesigning of the public spaces for climate change and to a greater extent evaluating the implementation and effectiveness of these strategies to create climate-responsive public spaces aimed to adapt the cities towards climate change.

RESEARCH OBJECTIVES

1 Assessing the vulnerability

This objective aims to evaluate current vulnerabiltiy of urban areas to effects of climate change such as extreme heat, flooding etc. and identify potential public spaces

2 Analyzing the role of public spaces

The objective focuses on understanding how public spaces can be adapted to climate change & which strategies can be the most effective while transitioning from theory to practice

3 Redesigning the public spaces

The objective aims to redevelop pulic spaces in urban areas by implementing effective design strategies to design adaptive public spaces and further making cities more sustainable and climate-resilient

Fig 5. Objectives of the research - Author's elaboration

1.6.

Introduction |
Framework & Methodology

The present thesis is divided in three main parts starting from understanding, analyzing and designing. Firstly, the primary stage of the research focuses on the theories related to the topic of urbanization, climate change and its adaptation, and the major role of public spaces at local scale in activating them and redesigning them for the climate change and further theoretically understanding how they can have positive impacts on national and global scale. Secondly, the thesis is focusing on understanding and analyzing successful case-studies related to the project of designing public spaces across the world in different context and dealing with different issues related to climate change, to acquire the knowledge about the design strategies used in those projects towards adaptation of climate change. Lastly, the last part of the research is based on the design proposal in which the identified public space is redesigned based on the gained knowledge from the theories and analysis, to further adapting cities to climate change and make it more sustainable and resilient.

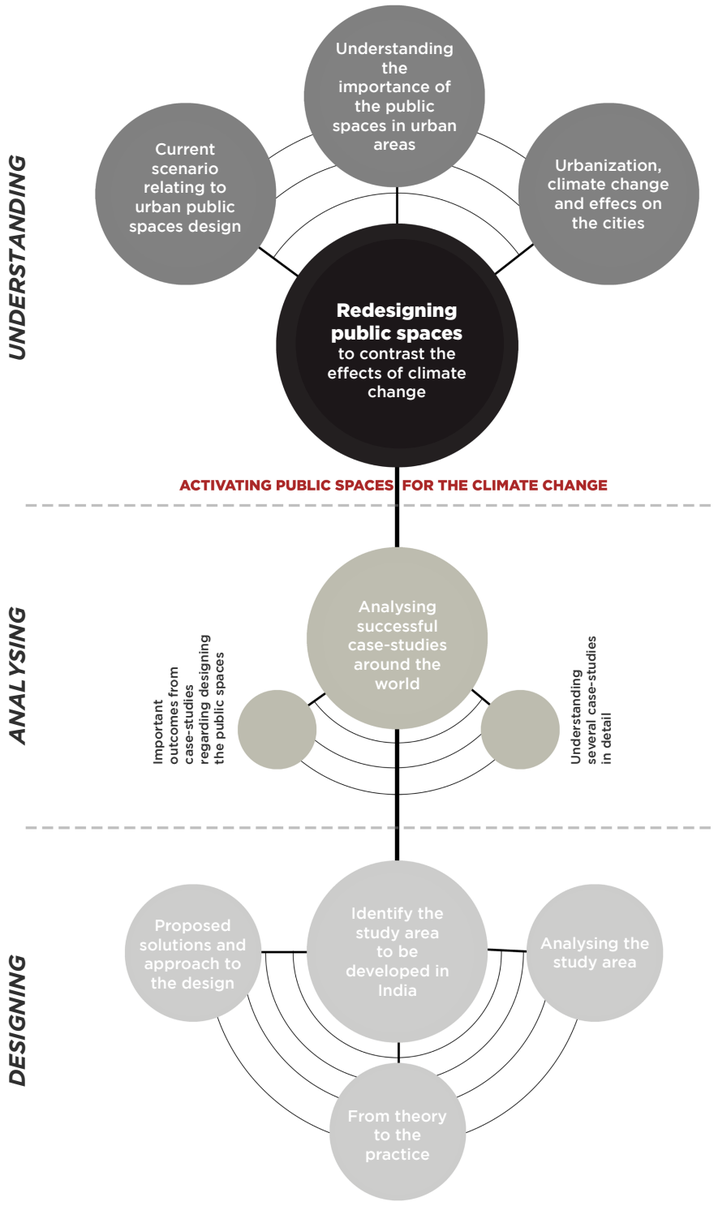


Fig 6 (Previous page). Framework and methodology of research - Author's elaboration

CHAPTER

02

DESIGNING PUBLIC SPACES FOR CLIMATE CHANGE

2.1.

Designing public spaces for climate change | Urbanization and Climate change

Notably, the world has been urbanizing abruptly over the past decades, with having more than half of the world's population now residing in cities, growing from 30 per cent in 1950 to around 55 percent in recent times (Nations et al., 2018). Furthermore, it is expected to increase by another 2.5 billion dwellers in an urban area by 2050, from which around 90% increase is accounted only in Asia and Africa (Generating Power | United Nations). With extreme amount of concentration of population, cities are responsible for the consumption of nearly 78% of the world's total energy as well as inducing the highest greenhouse gas emissions with them covering barely 2% of the global surface (Generating Power | United Nations), making cities more vulnerable towards climate change impacts, with affecting countless people in urban areas by extreme heat periods, increased precipitation, frequent floods and stronger storms as well as rising sea-levels (Climate Change | UN-Habitat). Although being a significant driver of socio-economic development, urbanization builds pressure in regard of liveable spaces for the urban population and further severely impacting landscapes, local ecosystems, and the environment. The physical feature and form of the surface, the balance and the dynamics of the atmosphere, as well as storing and channeling of the water all are impacted as a consequence of urbanization (Bai et al., 2017), thus, affecting the local climate and adding more pressure on the existing issues. Therefore, it emerges a need for the sustainable development of these urban areas around the world in this era of inevitable urbanization. Admittedly, numerous cities around the globe have started addressing the urban policies to reduce emissions, favouring the use of alternative energy sources and strategies to adapt to the changing climate, however, in order to keep up with the rapid population expansion and climate change, the process required to be accelerated (Generating Power | United Nations).

Total population of the world

8.1 billion

Percentage of total population in India

17% of whole world population

Percentage of total population living in Indian cities

35% of total Indian population

Fig 7. Statistical data - Author's elaboration

As a result of the consolidated anthropogenic actions, mainly due to greenhouse gas emissions, climate change is a severe threat worldwide with an array of environmental, economic, and social aspects, causing large-scale effects on environment. Global greenhouse gas emissions are constantly augmenting due to on-going addition from unsustainable energy utilization, land-use and its changes, patterns of production and consumption as well as lifestyle of people across the world (Romero et al., 2023). According to IPCC report, human-induced activities have resulted in 1°C global warming relative to pre-industrial levels (Romero et al., 2023) and based on current circumstances, global warming has been estimated to rise by about 1.5°C between 2030 and 2052, and about 3°C until 2100, which will have calamitous effects on the cities including adverse impacts on the infrastructures, quality of life as well as access to the urban services (Climate Change | UN-Habitat). Some of the main impacts that climate change has on the urban areas across the globe includes extreme weather episodes and flooding, severe heat waves and higher temperature, rise in sea level, intense storms, air pollution, low air quality as well as water pollutions (Balaban, 2012). These effects proliferate across ecosystems, affecting biodiversity, food security and human livelihoods. Furthermore, climate change poses higher risks on human health apart from other hazards and multiple risks, including an increase in heat-related human mortality and morbidity, diseases related to food-borne, water-borne as well as vector-borne and mental health challenges (Romero et al., 2023). These climate risks, projected sever effects, the losses and damages are further in the combination with non-climatic risks, urbanization and rapid population growth is making the urban areas and urban dwellers extremely vulnerable for the incremental challenges in the future. Ultimately, climate change jeopardizes both human health and health of a planet, with some of the inevitable and irreversible future impacts. However, they can be reduced by profound, sustainable and quick measures in the reduction of global greenhouse gas emissions, along with climate resilient urban development which integrated adaptation and mitigation actions, growing international cooperation between several vulnerable regions, sectors and government, sufficient financial resources as well as coordinated policies at national, regional and local level focusing at the making cities resilient and sustainable for the future (Romero et al., 2023).

“If the purpose of planning is not for human and planetary health, then what it is for?”

- UN

Source - (UN-Habitat and World Health Organization, 2020)
Com, I. (2020). Integrating health in urban and territorial planning: A sourcebook. http://apps.who.int/bookorders.

2.2.

Designing public spaces for climate change | Adaptation to climate change

Despite the fact that humans have always adapted to their environments, the climate change entails new and peculiar problems that endanger lives and livelihoods, thus, making the interest in the much-needed concept of climate change adaptation grow rapidly in recent times due to rising threats and impending uncertainties (Doherty et al., 2016). After the term was first defined by the Intergovernmental Panel on Climate change, the Conference of the Parties (COP) of United Nation Framework Convention on Climate Change (UNFCCC) have significantly contributed to this developing field of practice with higher emphasis on the core goal of Paris Agreement (COP21) on adaptation of "enhancing adaptive capacity, strengthening resilience, and reducing vulnerability to climate change, with a view to contributing to sustainable development in the context of global temperature goal" (Doherty et al., 2016). Amongst various sectors and regions, considerable progress in adaptation planning and its implementation has been realized, resulting in many advantages ranging from city's capacity to withstand and retrieve from extreme events, ecosystem protection as well as better human health. However, the challenges in adaptation planning exist and will continue to grow the gaps according to current circumstances, mainly due to constraints in financial resources, uncertainties in the prediction, as well as governmental and policy constraints (Romero et al., 2023).

Fig 8. Global climate strike
Vega, S., & Vega, S. (2019, September 16). How You Can Join The Global Climate Strike This Friday, September 20th. One Green Planet. https://www.onegreenplanet.org/environment/how-join-global-climate-strike-sept-20/

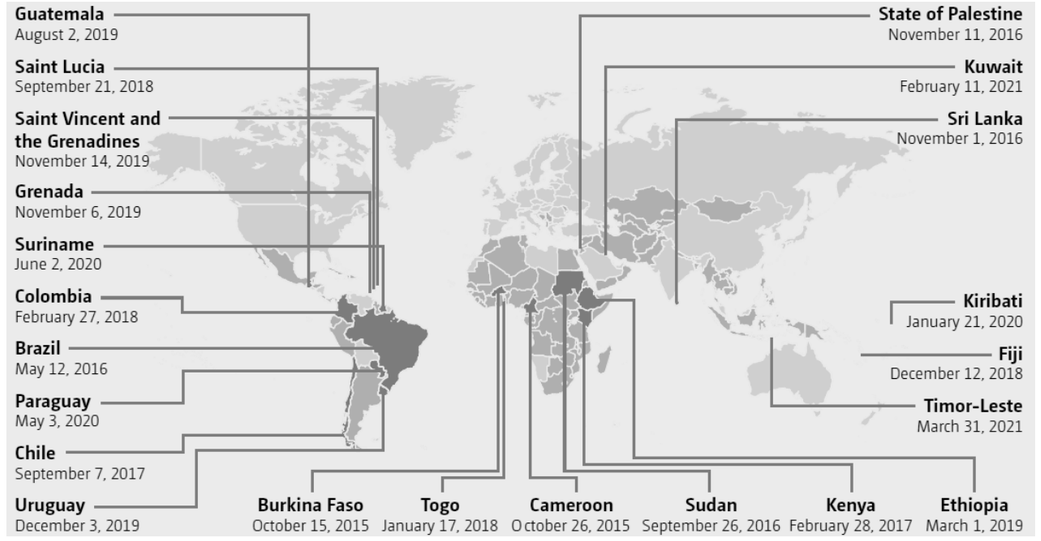


Fig 9. National Adaptation Plan in developing countries
National Adaptation Plans | UNFCCC. Retrieved December 2, 2023, from https://unfccc.int/topics/adaptation-and-resilience/workstreams/national-adaptation-plans

Considering that cities are highly vulnerable to the impacts of climate change as they are major centre of populations and economic activities, integrating climate change adaptation into urban planning is believe to be an important aspect in order to enhance urban resilience, lower the threats as well as encourage sustainable development. Different sustainable development policies related to those of the smart cities, resilient cities, carbon-neutral cities, contribute in the formation of new possibilities for sustainable urban development. Significantly, the Sustainable Development Goals (SDGs) adopted by UN have help generate attention towards the broader social, cultural, economic, political, institutional, and normative aspects of development of multidimensional operational methods in reality (Solecki et al., 2018). With cities facing increasing challenges from climate change, SDGs help in providing an insight of the opportunity for significant changes in cities, playing the role to merge the gap in adaptation planning and its implementation, as cities are the crucial spots for implementing them and shaping resilient as well as sustainable future for the future. Particularly, SDG-11 focusing on making cities more inclusive, sustainable, resilient, and safe can help in fostering climate resiliency, along with the SDG-13 targeting at taking quick actions towards enhancing the capacity of the cities to encounter the climate change impacts. Besides, incorporating climate change adaptation with urban planning can significantly contribute in producing climate resilient urban infrastructure including the green and blue infrastructure that can manage as well as reduce the issues related to stormwater management, Urban Heat Island effect (UHI) and energy-efficiency.

Furthermore, resilience has started becoming an important notion in the framework of urban planning, with several global initiatives including 100 Resilient Cities (100RC) as a starting point which is emphasizing on building resilience of the cities for the sustainable growth (Woodruff et al., 2022a). While climate change adaptation targets on altering the urban system to cope with impacts of climate change and mitigation focusing on reducing the greenhouse gas emissions, the concept of resilience emphasizes on the broader perspective, specifically on the ability of the cities to recover from the damage not just related to climate change but also those related to economic, social, and environmental aspects. Nevertheless, these varied yet interconnected concepts can help in better addressing the issues related to climate change in the urban areas and further build sustainable and resilience cities for the future.

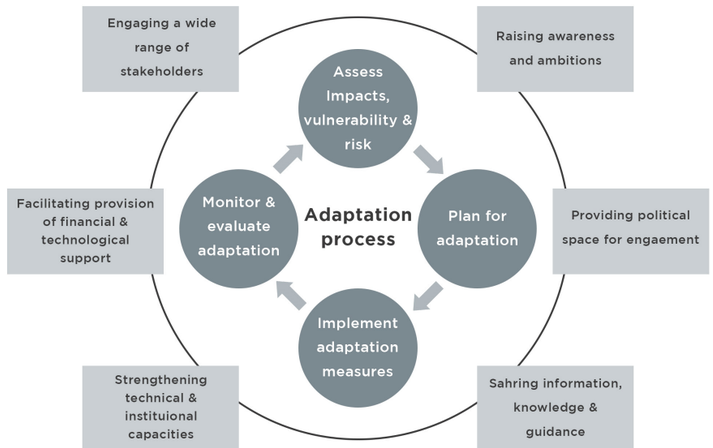


Fig 10. Adaptation process
Gee, A. (2021, February 14). What does climate adaptation and resilience look like? Global Center on Adaptation. Retrieved December 1, 2023, from https://gca.org/what-does-climate-adaptation-and-resilience-look-like/

2.3.

Designing public spaces for climate change | Collaborative solutions

Remarkably, distinct solutions are ineffective at dealing with the complexity of the global challenge of climate change, which requires an integration of different solutions having different qualities in order to provide essential elements to facilitate positive transformation (Land et al., 2021). Climate change adaptation and mitigation are often combined with the long-term risk management, facilitating a comprehensive knowledge of decision-making choices at all stages, with mitigation often having global long-term benefits, while adaptation having localized short-term benefits (Denton et al., 2014; Kyriakopoulos & Sebos, 2023; Pasimeni et al., 2019). Similarly, resilience plans appear to be more comprehensive in relation to both systems and risks analyzed as well as the stakeholders involved, having broad perspective including other aspects of social, economic and environment sustainability (Woodruff et al., 2022b).

However, while mitigation decisions happen to be often made by major groups or at a larger level, the adaptation mostly falls under the responsibility of local administrators with the support of national and global level (Denton et al., 2014). These adaptation strategies that incorporate technological, natural, and social solutions can deliver many co-benefits in addressing complex socio-ecological concerns with making cities more resilient to the possible future impacts (Land et al., 2021).

Climate change extreme have significant impact on sustainable development, provoking transformative changes in human and environmental systems (Kyriakopoulos & Sebos, 2023). Although, it is crucial to consider various components when evaluating these combined strategies, including avoiding trade-offs, recognizing synergies, improving response capacity, establishing institutional links, mainstreaming adaptation and mitigation considerations in the wider sustainable development policies in the urban areas (Denton et al., 2014). Furthermore, climate change adaptation along with its integration with other strategies, is more efficient at local-scale, contributing to bottom-up approach by including measures related to those of Nature-based Solutions (NBS), Green infrastructure (GI) as well as Community-based Adaptation (CBA), which help in leading cities faster towards carbon-neutrality and resilience (Ramalho et al., 2022).

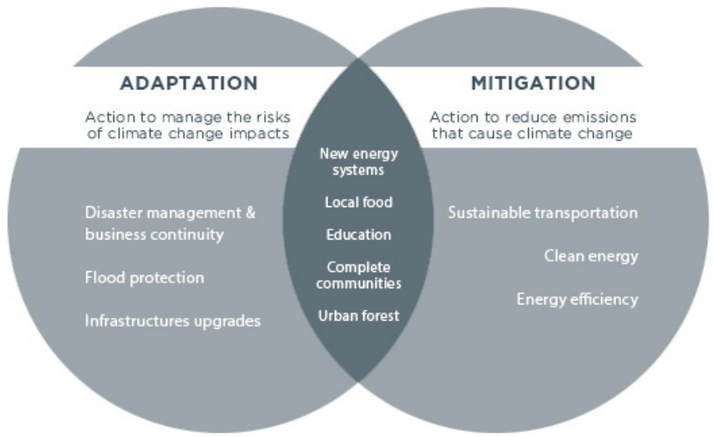


Fig 11. Building climate resilience
Sangsanguan, S. (2020, January 10). Building Climate Resilience. Pinterest. Retrieved December 1, 2023, from https://in.pinterest.com/

2.4.

Designing public spaces for climate change |

Role of Public spaces in adapting to climate change

As an essential social and environmental asset, public spaces are potentially effective change drivers, whose benefits may help to address a wide range of community needs starting from sustainability to safety, while also serving as an anchor that enhances community health and vibrancy. Cities which are facilitated by well-designed public spaces have a greater ability to guard against a variety of social problems including environmental degradation and crime (Biber Architects, 2023). On a broader scale, public spaces consistently serve a significant role as both the perceived centres of a variety of settlements as well as the focal point for public life and events, while on a smaller scale, they serve as a place to relax, play and creating a visual break in the flow of movement through urban areas (Carmona, 2019). Public spaces are an essential component of prosperous cities and the cities with an unwavering sense of the 'public', exhibit their dedication towards improving the quality of life for its residents with desirable street spaces, green areas, parks, leisure areas and other public spaces. Besides, the vitality and constant use of public spaces with well-maintained, healthy, and safe urban surroundings, makes cities more viable place to live. According to UN-Habitat, it is important to integrate an approach of urban planning which considers sustainable use and equal access to the public spaces through relevant policies, which can help in addressing the recent challenges of urbanization, climate change, inequalities, urban mobility, urban biodiversity as well as energy efficiency, additionally, establishing and organizing these public spaces with providing appropriate uses to increase the sense of identity and belonging in the cities (Martinez-Bäckström et al., 2016). As stated in the Leipzig Charter on Sustainable European Cities, "the quality of public spaces, man-made landscapes and architecture and urban development play an important role in the living conditions of urban populations" (The New Leipzig Charter, 2020).

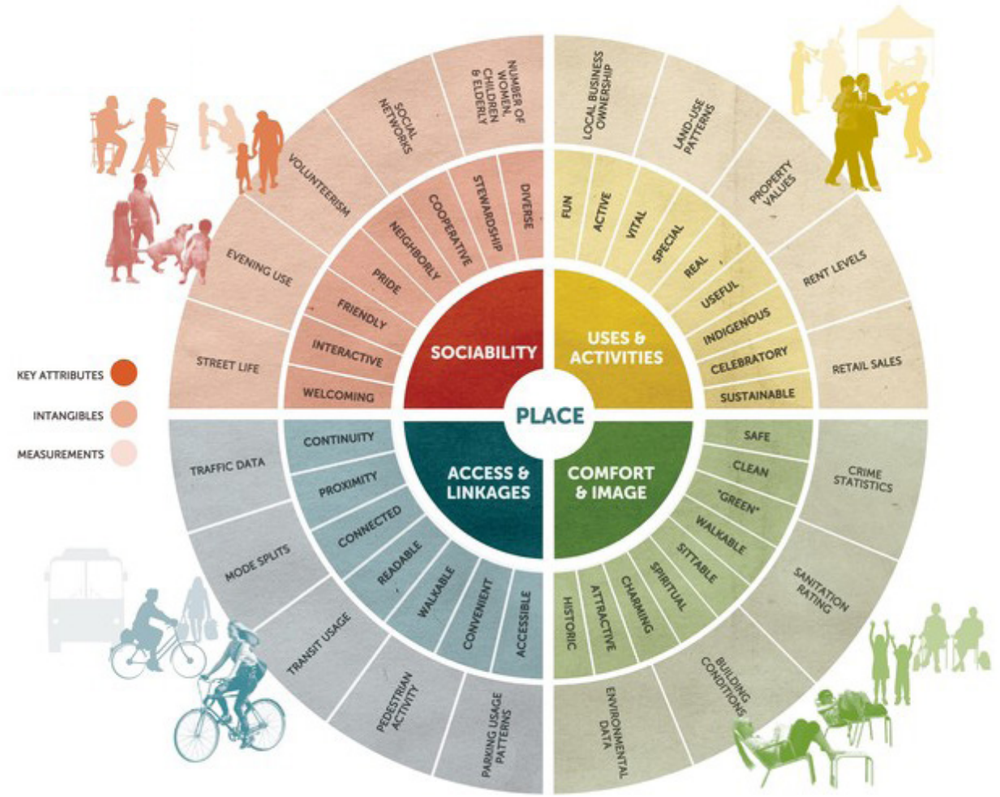


Fig 12. Successful place
What Makes a Successful Place? https://www.pps.org/article/grplacefeat

2.5.

Designing public spaces for climate change |

Current notions of planning and designing public spaces

The influence of urbanization on the connection amongst people and the environment is crucial when designing the urban public spaces (El Khateeb & Shawket, 2022a), and this increasing trend of urbanization along with recent global events are increasing the demand for space while putting much pressure on the public spaces which are sacrificed as a result of it (Global Public Space Programme, 2021), which has emerged a need for extensive design solutions to the rethinking of public spaces. Additionally, the recent COVID-19 pandemic has brought attention towards the establishment of open, green public spaces that promote health and well-being of the urban dwellers (El Khateeb & Shawket, 2022b). Besides, the ongoing climate change issues have emphasized the importance of public spaces for authorities across the globe to integrate the measures in the planning of public spaces to deal with the severe impacts of climate change. Over the decades, various public spaces have seen a revival, becoming an increasingly important component of many regenerations as well as development processes and the field of urban planning has an important role in the planning and designing of these public spaces through their frameworks and policies (Carmona, 2019). Furthermore, public spaces have been incorporated in National Urban Agendas (NUA) since the beginning of the 21st century and numerous countries have established the required frameworks and prospects that encourage inclusion of public spaces as well as emphasize the importance of them with the support of progressive national urban policies. These coordination and discourses have helped in establishing a cohesive vision and a better response to the public space concerns at the local and national level.

Specifically, Sustainable Development Goal (SDG) 11.7 emphasizes on the importance of prioritizing public spaces stating that “by 2030, provide universal access to safe, inclusive and accessible, green and public space” (Goal 11 | Sustainable development). This surely demonstrates the global determination in designing and maintaining public spaces that are inclusive and sustainable. Authorities across the world have started promoting urban planning policies with the designing of public spaces that considers them as drivers of economy benefiting various businesses.

Secondly, the public spaces that are designed to promote walking, cycling and other sustainable modes of transport that produce safe environment by reducing congestions and CO2 emissions. Similarly, well-planned public space system in cities that develop green networks to revitalize ecological systems and environmental intersection in urban areas, promoting biodiversity. Key focus has been given also in making mixed and diverse public spaces that enhances the safety along with much more attention towards equity and social inclusion that emphasizes on planning the public spaces which are accessible to all.

Additionally, different cities have started harmonizing new technologies and creative practices to enhance the quality of public spaces (Martinez-Bäckström et al., 2016). However, there still remains a gap in transitioning urban planning policies into practice while designing and planning the public spaces in urban areas. In the time of confronting range of transformation, the public spaces serve a substantial role

in the major future challenges that cities are going to face including those related to climate change (Duivenvoorden et al., 2021). Also, it is evident from the COVID-19 pandemic that apart from its negative effects, nature appears to have pressed the reset button and acquired the spaces to repair itself as anthropogenic activities in the urban areas were halted (Kumar et al., 2020), which gives the further evidence on the fact that urban planning policies that promotes thoughtful designing and planning of urban public spaces can be an opportunity for comprehensive climate adaptation and enhanced resilience (Peinhardt, 2021).

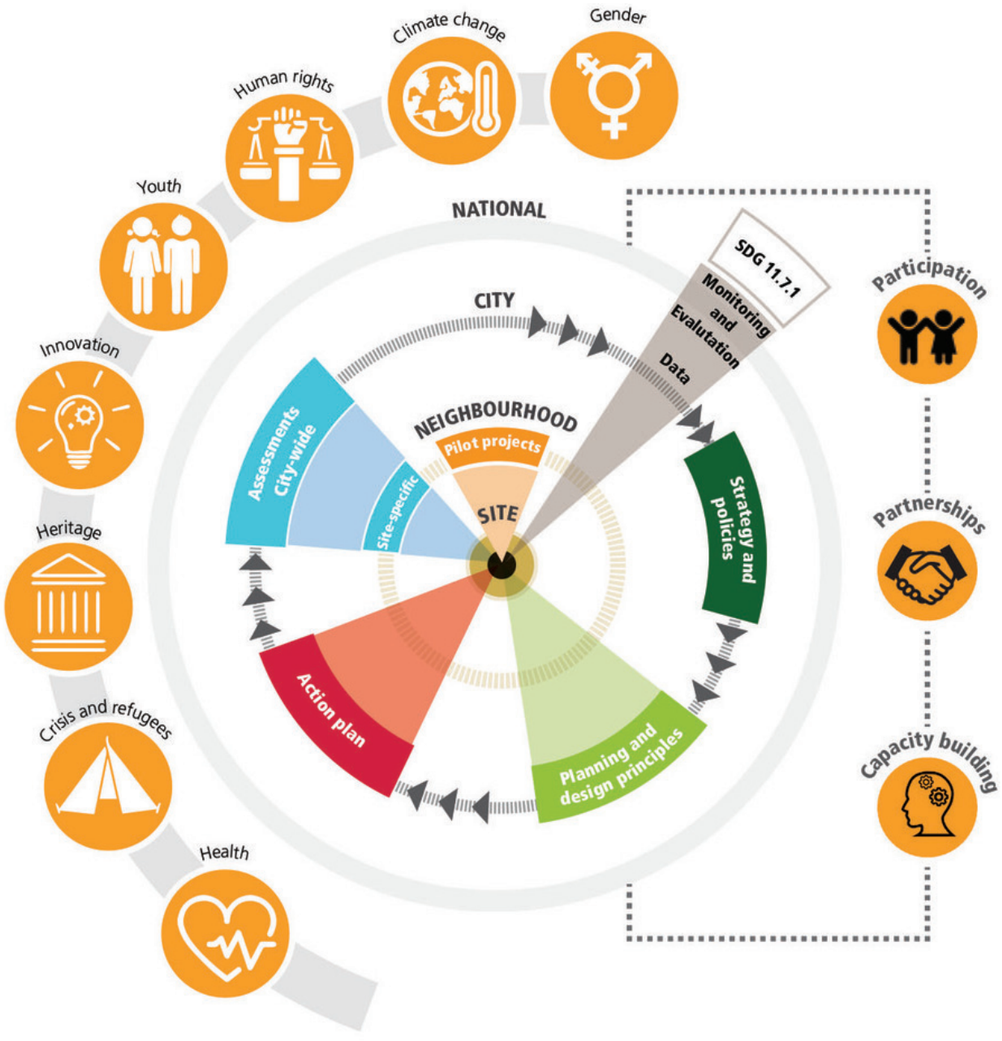


Fig 13. Steps to achieve quality public space at neighborhood level
Harrouk, C. (2022, August 18). 11 Steps to Achieve Quality Public Spaces at a Neighborhood Level: UN-Habitat's Guideline. ArchDaily. Retrieved December 1, 2023, from https://www.archdaily.com/948252/11-steps-to-achieve-quality-public-spaces-at-a-neighborhood-level-un-habitats-guideline

2.6.

Designing public spaces for climate change | Activating public spaces for climate change

Undoubtedly, there is an increasing need to make more efficient use of existing spaces in an urban area. Recently, public spaces are started to be considered as a means of physical resilience with range of benefits including distribution hubs for post-disaster aids, filtering stormwater due to prolonged rainfall as well as for resistant towards coastal sea rise, which evidently suggests that public spaces can be activated as a part of climate-adaptation and urban resilience strategies (Peinhardt, 2021). With emerging innovative concepts that shows the potential for evolving towards more socially oriented adaptation actions such as Community-based adaptation (CBA), which is recent approach in adaptation planning. However, there is still a little progress in connecting these inclusive forms of urban climate adaptation with the development of public spaces. Although several cities across the world have started integrating public spaces in the climate change adaptation strategies, which indicates the prospect for a growing possibility of cities considering public spaces as a valuable resource for adapting cities faster towards climate change (Peinhardt, 2021). Copenhagen is a successful example for adapting public spaces for climate change to store and manage the stormwater due to heavy rainfall (Copenhagen, 2011).

Fig 14. Activists held a climate rally at Philadelphia City Hall
Schmidt, S. (2023, October 17). 'We can have nice things': Philly climate activists rally for investments in public spaces. WHYY. Retrieved December 1, 2023, from https://whyy.org/articles/philadelphia-sunrise-climate-investments-public-spaces/

Fig 15. City and nature
January 2022 - Resilient Cities Network. Resilient Cities Network. Retrieved December 1, 2023, from https://resilientcitiesnetwork.org/2022/01/

The planet's climate is rapidly changing, causing sever effects and making the global cities significantly endangered by these phenomena, which urgently demands for the adaptation process of these cities (Battisti & Santucci, 2020). Public spaces provide an unprecedented opportunity to lead initiative in climate change adaptation measures as fundamental part of the urban fabric. The greatest chance of coping with these challenges is through well-designed and adaptable public spaces, which are softer, greener, and natural spaces, that can help in managing stormwater as well as regulating urban temperatures, while also helping in providing cooler and cleaner air with dense green vegetated areas in the cities (Public Space Lessons, 2008). Numerous cities across the globe have made the public spaces a priority, which also helps them in meeting the targets determined by the Sustainable Development Goals (UCLG, 2016). Integrating the public spaces in the adaptation strategies may help in identifying the city's specific vulnerabilities towards the climate change, further implementing innovative strategies to design and plan the public spaces focused on adapting towards the severe impacts that lead the cities across the world to be more resilient, sustainable, and climate-resilient (Brears, 2023). Additionally, the cities with successful models of sustainable public spaces can help in adapting cities faster towards climate change at local scale, while, also creating a paradigm for other cities to activate public spaces to deal with the issues of climate change, creating the multi-scalar positive effects at national as well as global level. At the same time, by incorporating local experience as well as scientific and technical knowledge in an adaptable and intuitive design, public spaces may not only support adaptation action and minimize hazard, but also raise climate change awareness. Furthermore, public spaces provide a network that simultaneously maintains the urban fabric but also links various urban spaces, ranging from buildings and infrastructure to natural systems that resemble the ecological network (Silva & Costa, 2018). Hence, a key approach in building climate-resilient cities is to examine the existing public spaces, identify opportunities and redesign them to efficiently use as a multi-purpose space of responding to the exacerbating issues of climate change that cities are facing in recent times (UIA - Urban Innovative Actions, 2022).

Fig 16. Upscaling
Harrouk, C. (2022, August 18). 11 Steps to Achieve Quality Public Spaces at a Neighborhood Level: UN-Habitat's Guideline. ArchDaily. Retrieved December 1, 2023, from https://www.archdaily.com/948252/11-steps-to-achieve-quality-public-spaces-at-a-neighborhood-level-un-habitats-guideline

As a major consequences of climate change, cities are increasingly experiencing the effects of Urban Heat Island (UHI) which is causing higher risks of heatwaves in urban territories and adverse effects on human health. However, UHI not only determined by the nature of physical process but also by urban planning strategies. Designing public spaces as a part of a green spaces strategy or green infrastructure plan can effectively help crucial urban areas to adapt towards the Urban Heat Island effects. Furthermore, planting more trees in a public space play an important role in adaptation, as they have vital role in cooling the air, providing shade, capturing carbon, and regulating the outdoor temperatures of an urban areas. Also, introducing water features in public spaces can significantly help in reducing air temperature through evaporation and creating more even temperature. Consequently, applying multiple green infrastructures in potential public spaces can not only lessen the vulnerability to UHI but also increase the adaptive capacity of the urban areas and lower the sensitivity of citizens (Leal Filho et al., 2018). Additionally, incorporating use of cool pavement, dense greenery and shading devices can be crucial in intercepting solar radiation, reducing air temperature and improving wind speed to enhance the micro-climate of the public spaces which are more sustainable and focused towards well-being of humans (Gaitani et al., 2011). Secondly, current stormwater management systems in the cities are facing significant challenges due to climate change and growing urbanization, resulting in the higher risks of frequent flood and surface run-off water (Zölch et al., 2017). Considering this, the public spaces that are designed to facilitate the advantage of filtering ability of plants, soils as well sand, with integrating design of public spaces with green infrastructure such as rain gardens bioretention trench, decentralized storage facilities as well as permeable pavement can help in increasing the capacity of accumulation, infiltration and purification of water in urban areas and further help in enhancing groundwater recharge and reducing pressure on stormwater management and risk of flooding, which is significantly be seen in the example of sponge city concept (SPC) in China (Yin et al., 2021). Finally, integrating the strategic planning and designing of public spaces in an urban planning and climate change adaptation policies can substantially help in activating these existing public spaces at local scale in mitigating the severe impacts of climate change in an urban areas by decreasing the vulnerability and improving capacity, while making the cities more sustainable, resilient, climate proof and human centred, by further escalating its positive benefits towards national and global level towards the concept of climate change adaptation.

2.7.

Designing public spaces for climate change | From planning to design

Fig 17. Nature-based solutions - C. (2021, July 5). Nature-based solutions and climate change. Pinterest. Retrieved November 27, 2023, from https://in.pinterest.com/pin/598275131764149679/

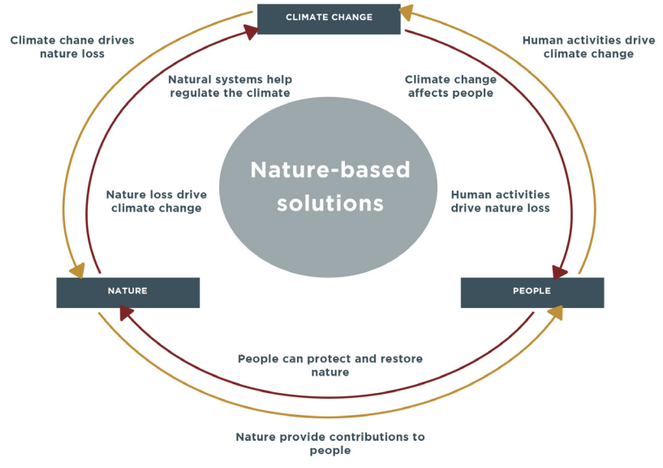


Fig 18. Nature-based solutions - URBAN NATURE BASED SOLUTIONS. (2021). https://wwf.panda.org/projects/one_planet_cities/what_we_do/urban_naturebased_solutions/

Indeed, consolidating the utilization of Nature-based solutions (NBSs) and Green-Infrastructures (GIs) in designing public spaces has considerable benefits in enhancing the quality of public spaces to adapt them towards climate change. Alongside, conventional grey infrastructure, green-infrastructures (GIs) have been recognized as 'best practices' in local-scale governance for achieving higher urban sustainability and resilience, as well as their significance in adapting to the arising and invincible effects of climate change with their other benefits in social, economic, and environmental aspects. Linking green-infrastructures (GIs) – such as green roofs, rain gardens, green walls, river parks, bioswales, and so on, with urban planning strategies promises to be one of the most suitable and successful strategies to enhance the micro-climate of public spaces and to deal with the consequences of climate change, particularly Urban heat island (UHI) effects. Favourably, they can offer a variety of climate change and ecosystem services that can significantly contribute to adaptation and mitigation of climate change, in addition to associated benefits to human health and well-being by creating more comfortable public spaces for outdoor activities (Sturiale & Scuderi, 2019). Similarly, Nature-based solutions (NBSs) utilize living organisms, soils, sediments, and landscape futures to alleviate climate change hazards and intense effects of urban features on those hazards, which demonstrate their potential role as more versatile, multi-functional and adaptable to an uncertain and unpredictable climate future (Cortinovis et al., 2022). NBSs can be incorporated into public spaces as a structural stormwater management measures, green parks, sustainable materials, and natural elements as well as the way of main-

taining and restoring natural ecosystems (Larsen, 2015). Furthermore, NBS have potential to mitigate the increased hazard of coastal flooding and erosion caused by stronger storm surges induced by sea-level rise, while also their strategic integration landscape may decrease the danger of flooding and harmful impacts of surface runoff (Zellner et al., 2016). Along with the ability to adapt to climate change, NBSs also bring social benefits such as accessible green spaces that aid in the improvement of mental and physical health of humans, while also lowering violence and crime. In addition, they also promote biodiversity in an evolving environment by creating habitat reserves and corridors for migratory species in the time of climate change (Cortinovis et al., 2022).

In conclusion, public spaces play a major role in an urban area to drive the adaptation process faster by integrating their design and planning with ongoing urban planning policies in the cities, which can help in creating a network of green spaces playing a vital role in adapting cities faster towards the climate change with associate benefits on a larger scale. Based on this research, the thesis further focuses on studying various case-studies which are considered as a successful model of planning and designing of public spaces across the world are analyzed and compared to better understand how theories can be implemented into practice in the field of climate change adaptation.

Fig 19 (Next page). Bishan-Ang Mo Kio park
2016 ASLA GENERAL DESIGN HONOR AWARDS: Bishan-Ang Mo Kio Park by Ramboll Studio Dreiseitl. Gooood. https://www.gooood.cn/2016-asla-bishan-ang-mo-kio-park-by-ramboll-studio-dreiseitl.htm

PART II

ANALYZING THE BEST CASES

CHAPTER

03

CASE STUDIES OF ADAPTIVE PUBLIC SPACES

3.1.

Case studies | Overview

Notably, the previous chapter discusses the importance of public spaces as a key component of the urban areas, which provide great opportunity to cope with the current urban challenges, especially those pertaining to climate change. It is evident that various literature as well as global and national policies have started emphasizing the importance about rethinking urban public spaces and incorporating their planning and design with a focus on climate resilience into urban planning and adaptation strategies in order to adapt cities faster towards climate change by giving significance to bringing positive changes at the local level to further have larger scale benefits. Despite this increasing attention to adapt public spaces against climate related concerns, the gap still remains while transitioning from research and policies to the actual implementation of climate change adaptation and resilience strategies as well as taking initiatives at the local scale (Caldarice et al., 2021). Scientific research supports cities in defining the effective policies towards the pathway of adaptation and resilience, while their connection with practice serves as an anchor for implementing these local policies in activating existing public spaces to deal with the issues of climate change. “Thus, the main challenge continues to exist in establishing the enhance connection between science, policy and practice” (Caldarice et al., 2021, p. 10). Certainly, theories transform into tangible representation in the physical world, therefore, with the purpose to better understand the development of theories into the practical implementation, the research focuses on various successful model of public spaces designed and planned across the world, having different context and dynamic solutions. Different instances from various worldwide locations were chosen to be examined by considering the fact that various urban areas across the globe faces multiple climate related challenges and therefore requires a mix of approaches to be dealt with. Initially, several well-accomplished case studies of the urban public spaces were identified in different cities of Europe, Asia/Pacific, North/South America, and Middle East in order to study them as a paradigm of how concepts are translated into tangible imperatives. Collectively, 44 case studies of urban public spaces were recognized with having 20 case-studies from cities in Europe, 15 case-studies from cities in Asia/Pacific, 8 case-studies from cities in North/Latin America and 1 from city in the Middle East. Further, these case studies were analyzed based on several criteria namely year of development, their geographical locations, type of climate impact addressed, spatial scale of the project as well as type of methodologies used along with their outputs, which further helped in establishing the connections between the theoretical concepts and implemented approaches, and how these local scale executions to adapt the public spaces towards climate change reproduce the desirable outcomes at various scale. Additionally, the type of climate impact addressed in all the cases were categorized meticulously in order to comprehensively include all aspects that are related to the urban environment while dealing with the issues of climate change, which consists: (1) Buildings & Energy, (2) Transportation & Land-use, (3) Water & Natural system, (4) Waste management, (5) Community resilience & adaptation, and (6) Municipal Policy.

3.2.

Case studies |
Successful case studies around the world

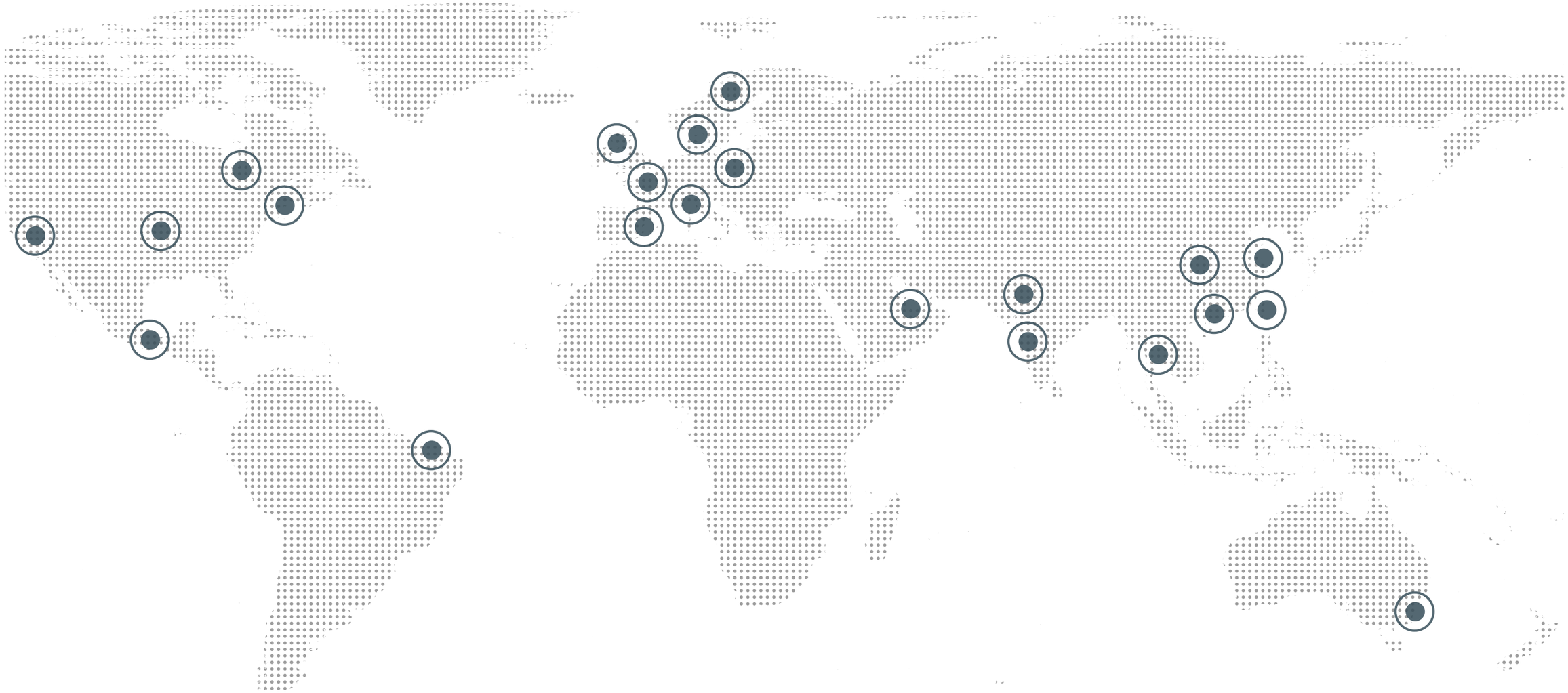
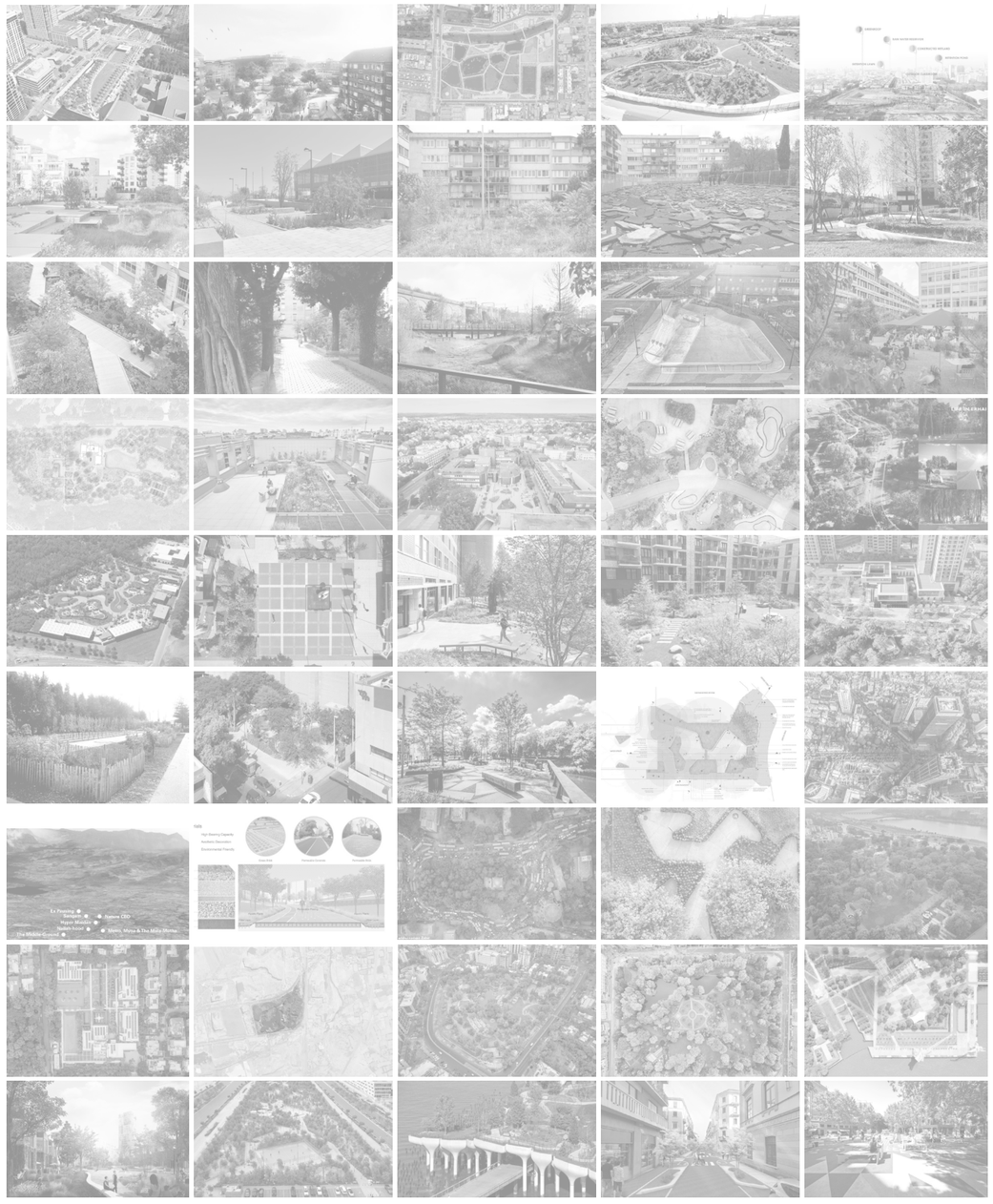


Fig 20. The world map showing different locations of total 44 identified case studies - Author's elaboration

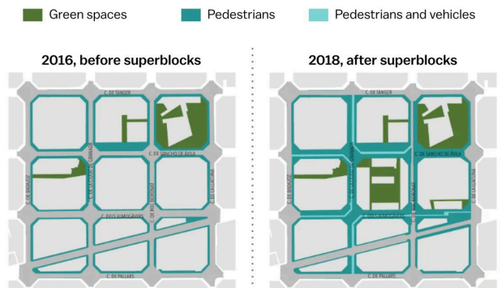


1. Climate district in Østerbro

Year – 2011-16
Location – Copenhagen, Denmark (Europe)
Spatial scale – Large
Climate impact add. – 1, 2, 3, 5, 6 (Climate district, combining city and nature)
Action - Adaptation

2. Valdocco Redevelopment

Year – 2022
Location – Turin, Italy (Europe)
Spatial scale – Large
Climate impact add. – 2, 3 (Green solutions, permeable areas, rainwater & UHI)
Action - Adaptation



3. Superblock

Year – 2005 and onwards
Location – Barcelona, Spain (Europe)
Spatial scale – Large
Climate impact add. – 2, 3, 5, 6 (Pedestrian centric, transport emissions & UHI)
Action - Adaptation & Mitigation

4. The South Harbor

Year – 2023
Location – Koge, Denmark (Europe)
Spatial scale – Large
Climate impact add. – 3, 5 (Nature-based neighborhood dev., Rainwater runoff)
Action - Adaptation

5. Jardin des Joyeux

Year – 2016
Location – France (Europe)
Spatial scale – Small
Climate impact add. – 3 (Biodiversity urban garden)
Action - Mitigation

6. Pedagogic Urban Garden

Year – 2011
Location – France (Europe)
Spatial scale – Small
Climate impact add. – 3 (Various ecosystem services, multiple sustainable interventions)
Action - Adaptation

7. Mayfield Park

Year – 2022
Location – Manchester, UK (Europe)
Spatial scale – Small
Climate impact add. – 3, 5 (Urban green space, Natural habitat)
Action - Adaptation

8. Elsa Eschelsson's Park

Year – 2022
Location – Sweden (Europe)
Spatial scale – Small
Climate impact add. – 3, 5 (Storm-water management, solutions related to the rain water)
Action - Adaptation

9. Atoms

Year – 2021
Location – Zurich, Switzerland (Europe)
Spatial scale – Small
Climate impact add. – 1, 3 (Helping in urban heat island effect)
Action - Adaptation

10. Comm. Court. & Roof Terrace

Year – 2020
Location – (Europe)
Spatial scale – Small
Climate impact add. – 1, 3 (Maximum green space and high usability in an urban areas)
Action - Adaptation

11. Konrad-Adenauer-Platz

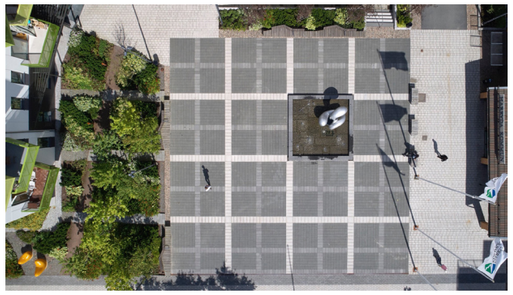
Year – 2021
Location – Germany (Europe)
Spatial scale – Small
Climate impact add. – 1, 3, (Urban Garden considering climate and ecological aspects, Helping in UHI)
Action - Adaptation

12. Strindfjordvegen Park

Year – 2018
Location – Norway (Europe)
Spatial scale – Small
Climate impact add. – 3 (Park dealing with surface runoff water, Helping in UHI)
Action - Adaptation

13. World Horticulture Exposition

Year – 2012
Location – Venlo, The Netherlands (Europe)
Spatial scale – Large
Climate impact add. – 3 (Horticulture sustainable park)
Action - Adaptation



14. Rada Torg

Year – 2022
Location – Gothenburg, Sweden (Europe)
Spatial scale – Small
Climate impact add. – 3 (Deals with surface water mangement, Rain-garden
Action - Adaptation

15. Postpark

Year – 2022
Location – Den Haag, The Netherlands (Europe)
Spatial scale – Small
Climate impact add. – 3 (High biodiversity urban park, Helping in UHI)
Action - Adaptation

16. Urban Campus Lieven

Year – 2022
Location – Amsterdam, The Netherlands (Europe)
Spatial scale – Small
Climate impact add. – 3 (Dealing with water management, Greener, healthier cities)
Action - Adaptation

17. Shoreline Park

Year – 2018
Location – Sweden (Europe)
Spatial scale – Small
Climate impact add. – 3, 4, 5 (Urban regeneration through the lens of climate issues about soil, air etc.)
Action - Adaptation

18. Rooftop Park

Year – 2015
Location – The Netherlands (Europe)
Spatial scale – Small
Climate impact add. – 1, 3 (Urban green spaces on the rood, using existing urban spaces)
Action - Adaptation

19. St. Stephen's Green Park

Year – Unknown
Location – Dublin, Ireland (Europe)
Spatial scale – Medium
Climate impact add. – 3 (Green park in the city centre, various ecosystem services, Helping in UHI)
Action - Adaptation

20. Bryggens Bastion

Year – 2015
Location – Amager, Copenhagen (Europe)
Spatial scale – Medium
Climate impact add. – 1, 2, 3, 5 (Green climate adaptation vision plan)
Action - Adaptation

21. Centenary Park

Year – 2019
Location – Bangkok, Thailand
(Asia/Pacific)
Spatial scale – Medium
Climate impact add. – 1, 2, 3, 5 (Dealing with flooding issues, Helping in UHI)
Action - Adaptation and Mitigation

22. Undulating Garden

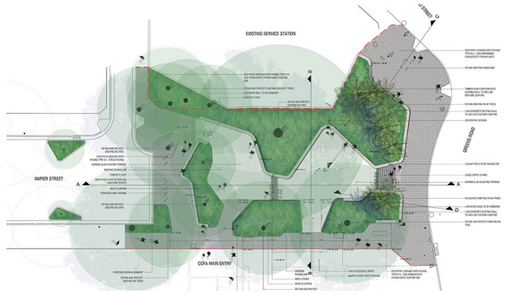
Year – 2018
Location – Taiwan
(Aisa/Pacific)
Spatial scale – Small
Climate impact add. – 3 (Helping in UHI, Using permeable materials)
Action - Adaptation

23. Erhai Lake

Year – 2021
Location – China
(Aisa/Pacific)
Spatial scale – Large
Climate impact add. – 2, 3, 5 (Resilient and sustainable waterscape)
Action - Adaptation and Mitigation

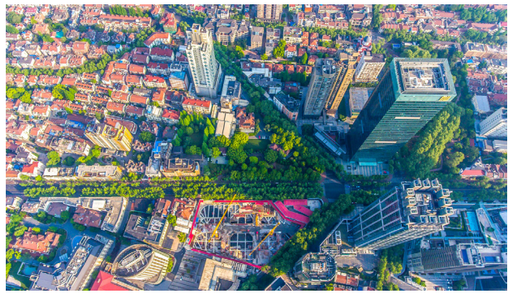
24. Green Neighbourhood

Year – 2022
Location – Shenzhen, China
(Aisa/Pacific)
Spatial scale – Medium
Climate impact add. – 1, 2, 3 (Deals with rainwater, Green streetscape)
Action - Adaptation



25. Napier Street Open Space

Year – 2014
Location – Sydney, Australia
(Aisa/Pacific)
Spatial scale – Small
Climate impact add. – 3 (Green road intersection, Planting opportunities, Padestrianization)
Action - Adaptation

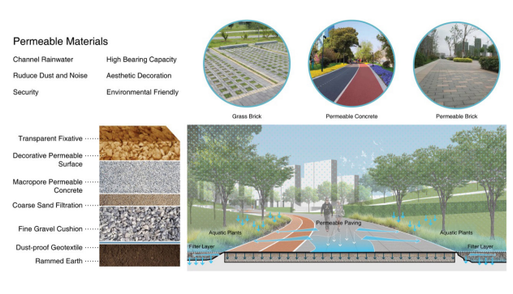


26. Donghu Park

Year – 2017
Location – Shanghai, China
(Aisa/Pacific)
Spatial scale – Small
Climate impact add. – 3 (Urban botanical park, Helping in UHI)
Action - Adaptation and Mitigation

27. The Mula Mutha Project

Year – 2019
Location – Pune, India
(Aisa/Pacific)
Spatial scale – Large
Climate impact add. – 3 (Resilience accelerator project, Considers ecology and economy)
Action - Adaptation and Mitigation



28. Jingkai Central Park

Year – 2020
Location – Nanchang, China
(Aisa/Pacific)
Spatial scale – Medium
Climate impact add. – 3 (Sustainable urban park)
Action - Adaptation and Mitigation

29. Bahadur Shah Park

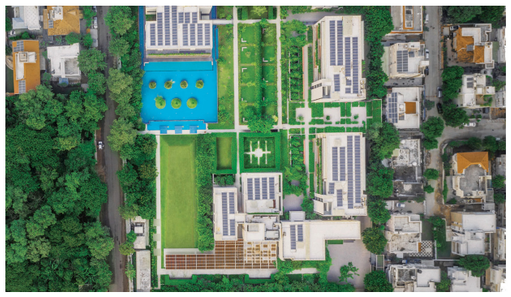
Year – Unknown
Location – Dhaka, Bangladesh
(Asia/Pacific)
Spatial scale – Small
Climate impact add. – 3 (Road junction helping in UHI)
Action - Adaptation and Mitigation

30. Udhyan Pravah

Year – After 2016
Location – Ahmedabad, India
(Aisa/Pacific)
Spatial scale –
Climate impact add. – 3, 5 (Functional and environmentally effective park)
Action - Adaptation and Mitigation

31. Victoria Park

Year – 2016
Location – Ahmedabad, India
(Aisa/Pacific)
Spatial scale – Medium
Climate impact add. – 3 (Garden in dense built fabric, Helping in UHI)
Action - Adaptation and Mitigation



32. Samnvay - Workspace Garden

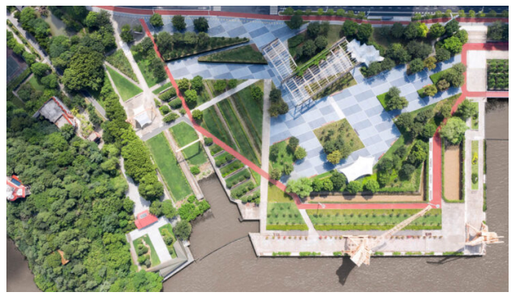
Year – After 2016
Location – Ahmedabad, India
(Aisa/Pacific)
Spatial scale – Small
Climate impact add. – 3 (Green in the urban fabric, multiple ecosystems)
Action - Adaptation

33. Timba Basalt Quarry

Year – After 2016
Location – Timba, India
(Aisa/Pacific)
Spatial scale – Large
Climate impact add. – 3 (Rejuvenation of land to create self-sustaining ecosystems)
Action - Adaptation and Mitigation

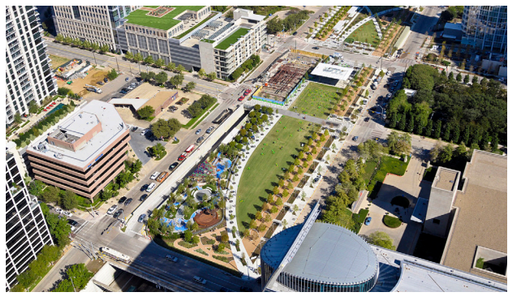
34. Parimal Garden

Year – Unknown
Location – Ahemdabad, India
(Aisa/Pacific)
Spatial scale – Large
Climate impact add. – 3 (Sustainable model of urban park in dense urban fabric)
Action - Adaptation and Mitigation



35. Docklands Park

Year – 2012-2020
Location – Jiangyin, China
(Aisa/Pacific)
Spatial scale – Large
Climate impact add. – 1, 2, 3, 5 (Re-establishing the ecosystem corridors in urban area)
Action - Adaptation and Mitigation



36. Klyde Warren Park

Year – 2012
Location – Dallas, United States
(North/Latin America)
Spatial scale – Small
Climate impact add. – 2, 3 (Green urban space in between built fabric, Helping in UHI)
Action - Adaptation and Mitigation

37. Little Island Park / Pier 55

Year – 2021
Location – New York City, United States (North/Latin America)
Spatial scale – Small
Climate impact add. – 1, 3 (Green oasis above water, encourage biodiversity)
Action - Adaptation and Mitigation

38. Rachel de Queiroz

Year – 2022
Location – Fortaleza, Brazil (North/Latin America)
Spatial scale – Medium
Climate impact add. – 3, 4, 5 (Dump site turned into urban park, Flood preservation)
Action - Adaptation

39. Corktown Common Park

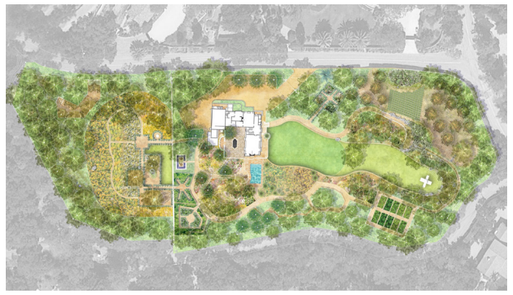
Year – 2013
Location – Toronto, Canada (North/Latin America)
Spatial scale – Large
Climate impact add. – 3, 5 (Flood resilience, Various ecosystem services)
Action - Adaptation

40. Jardin de Sombras

Year – 2019
Location – Mexico (North/Latin America)
Spatial scale – Small
Climate impact add. – 3, 5 (Helping in UHI, Includes disaster response system)
Action - Adaptation and Mitigation

41. Industry City

Year – 2016
Location – New York City, United States (North/Latin America)
Spatial scale – Small
Climate impact add. – 3 (Green space designed between buildings as a buffer)
Action - Adaptation and Mitigation



42. Mariposa Gardens

Year – 2021
Location – California, United States (North/Latin America)
Spatial scale – Small
Climate impact add. – 3 (Urban garden with climate resilience and sustainable strategies)
Action - Adaptation and Mitigation

43. Citizen Garden

Year – 2018
Location – Moterey, Mexico (North/Latin America)
Spatial scale – Small
Climate impact add. – 3 (Highly dense green urban space, Helping in UHI)
Action - Adaptation

44. Al Fay Park

Year – 2021
Location – Abu Dhabi, UAE (Middle East)
Spatial scale – Medium
Climate impact add. – 3 (Designing nature in dense mega cities, biodiversity & microclimate)
Action - Adaptation

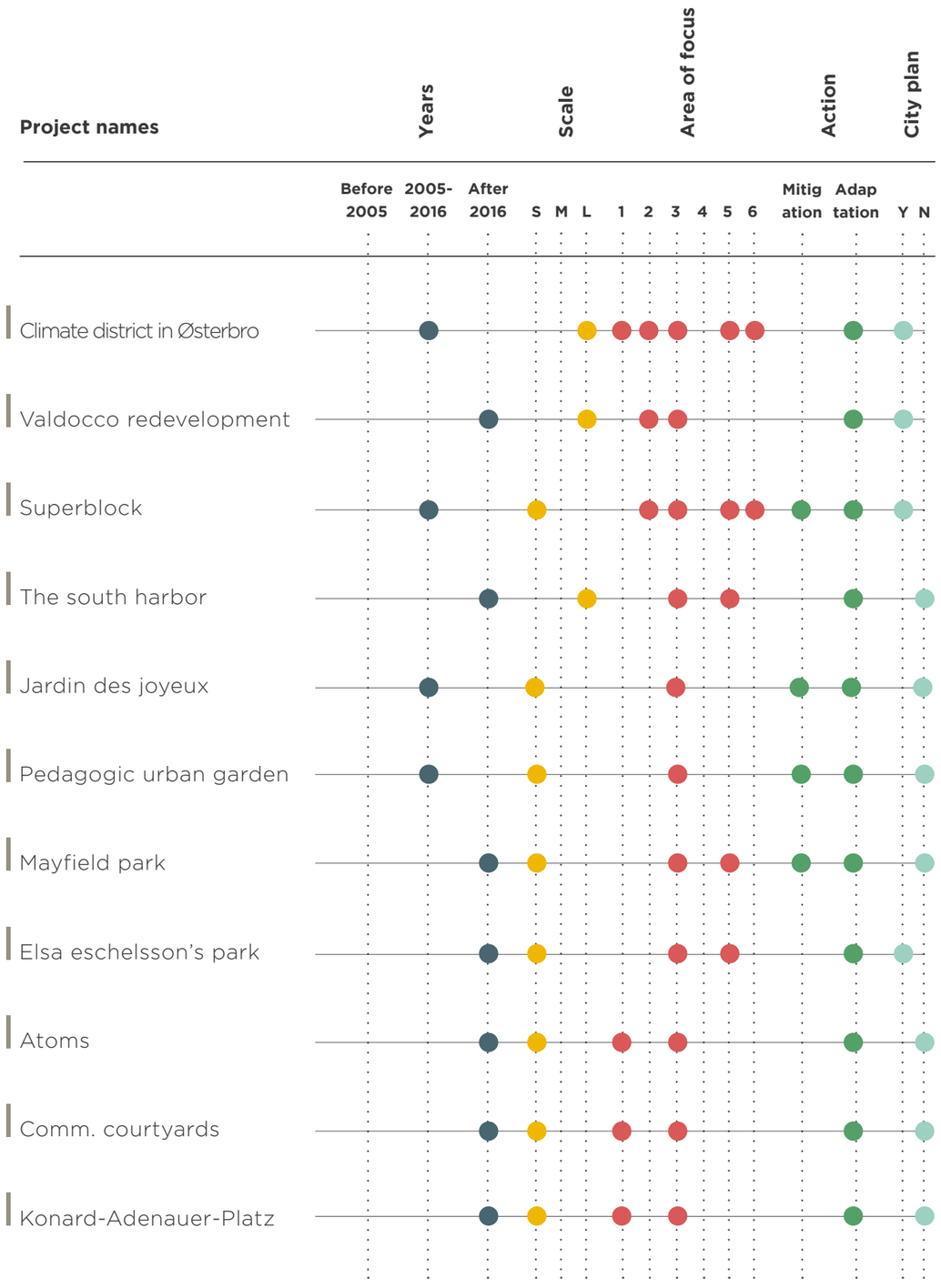
3.3.

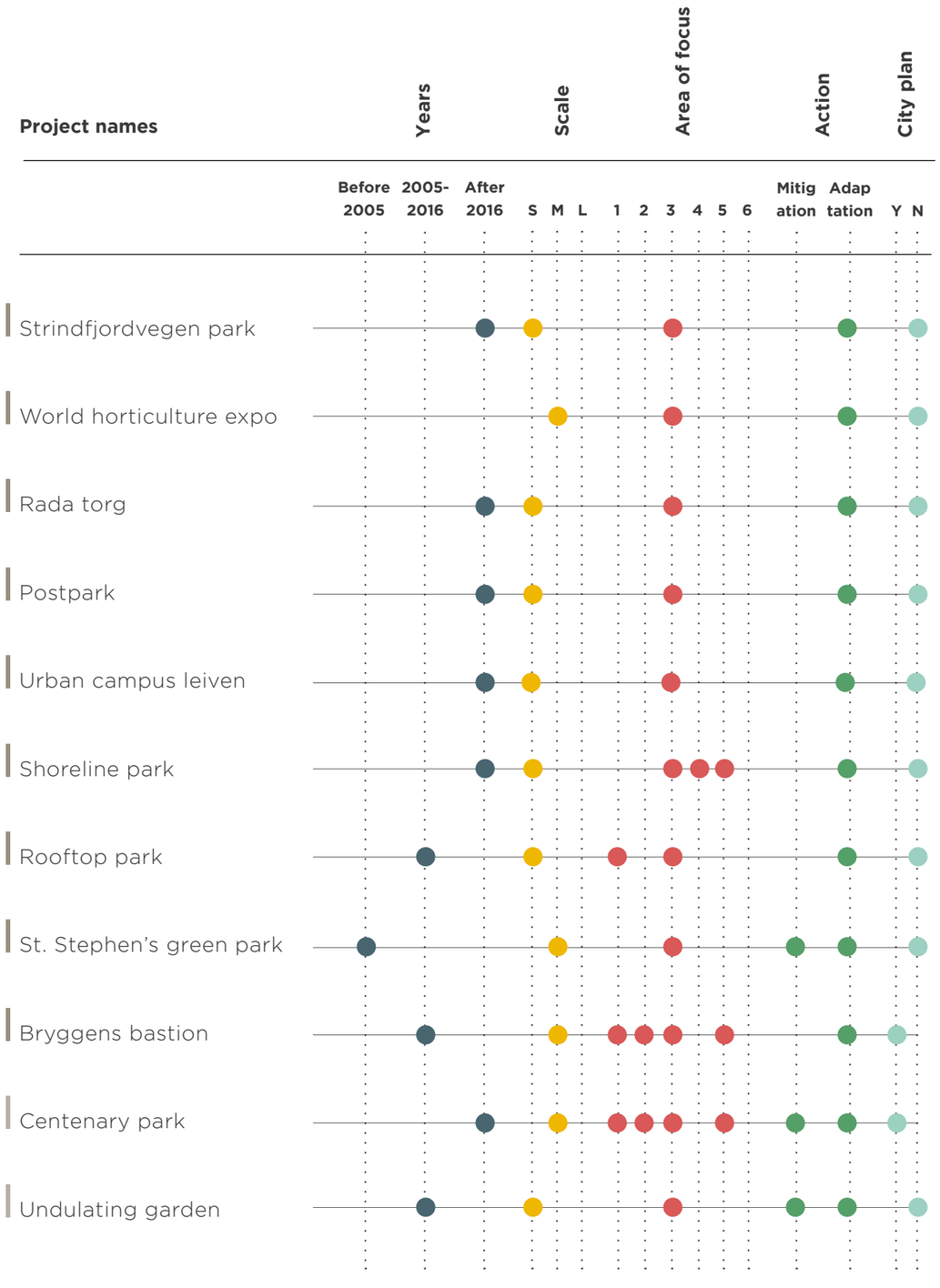
Case studies | Comparative analysis

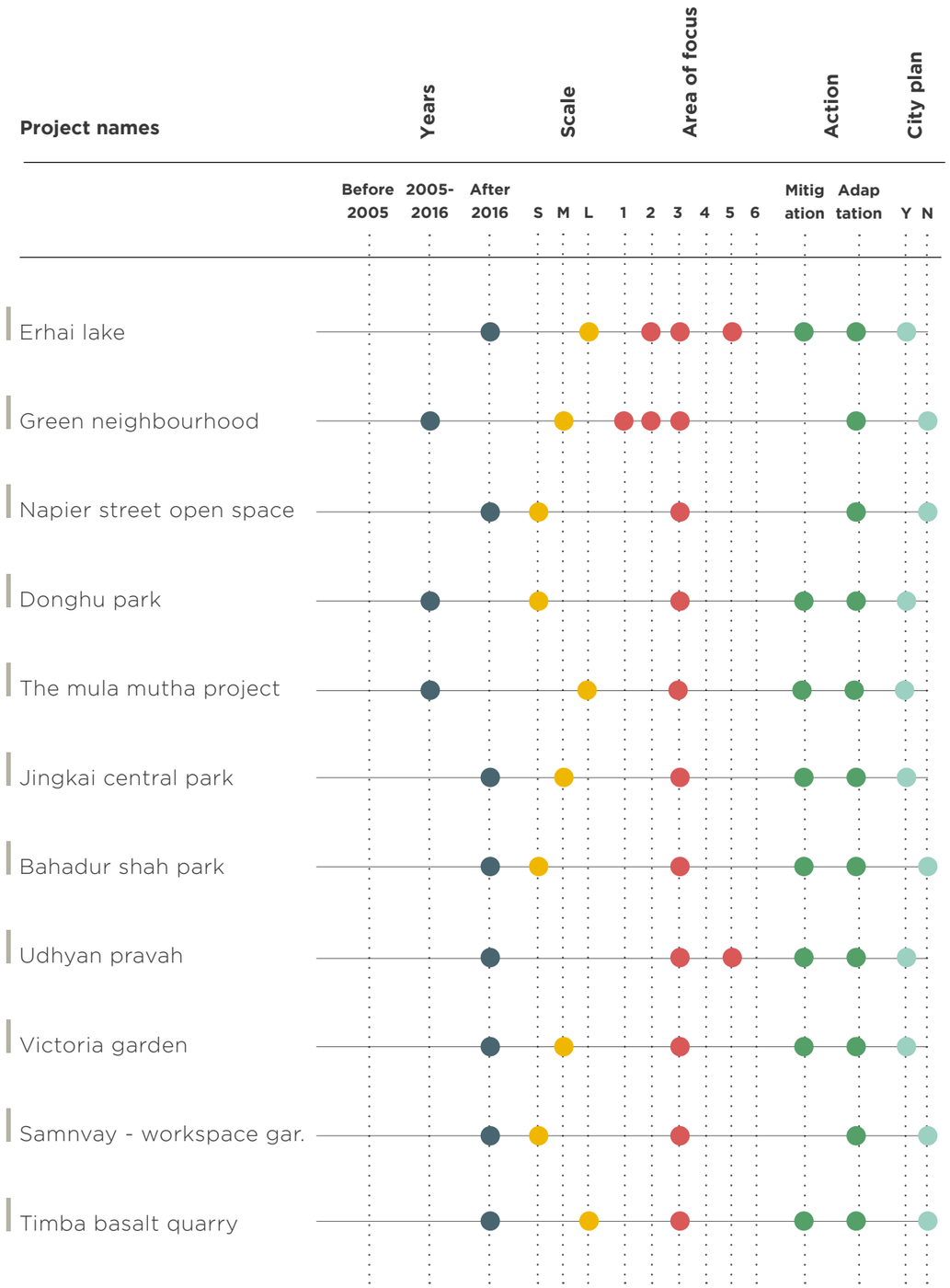
Further, these case studies were examined and juxtaposed through the means of comparison analysis matrix approach to analyse and compare them in accordance with their varied context. The comparison matrix was planned based on the criteria that were identified to be evaluated by listing various case-studies in rows while placing the criteria in the column, which were assessed in order to develop a qualitative characterization of each case. To comprise all the selected cases, the criteria regarding the year of development were carefully categorized into three groups with having projects which were built between the year of 2005-2012, those built between 2013-2020 and the ones built after year of 2020. Whereas, the criteria of spatial scale were classified into three types, mainly small-scale including those having built area below 40,000 m2, medium-scale cases with built area between 40,000 to 1,00,000 m2 and large-scale projects with built area above it. In order to draw meaningful conclusions, the observations were also carried out to check if the development mainly focused on adaptation or mitigation aspects while dealing with the climate change, additionally, the survey about whether all-selected projects were part of any municipal plan or strategies were also considered so as to review the effectiveness of local scale implementation on various scales. Indeed, this methodology facilitated in incorporating the information from various cases chosen to be studied, organize the research data in a systematic and comprehensive way as well as deriving significant insights from them. With the help of the matrix, the similarities, variations as well as trends were identified for all the case-studies based on their different context, which further helped in allowing to carry out more in-depth and thorough analysis of fewer of these cases to identify the specific design and planning strategies while utilizing public spaces to adapt the cities faster towards climate change.

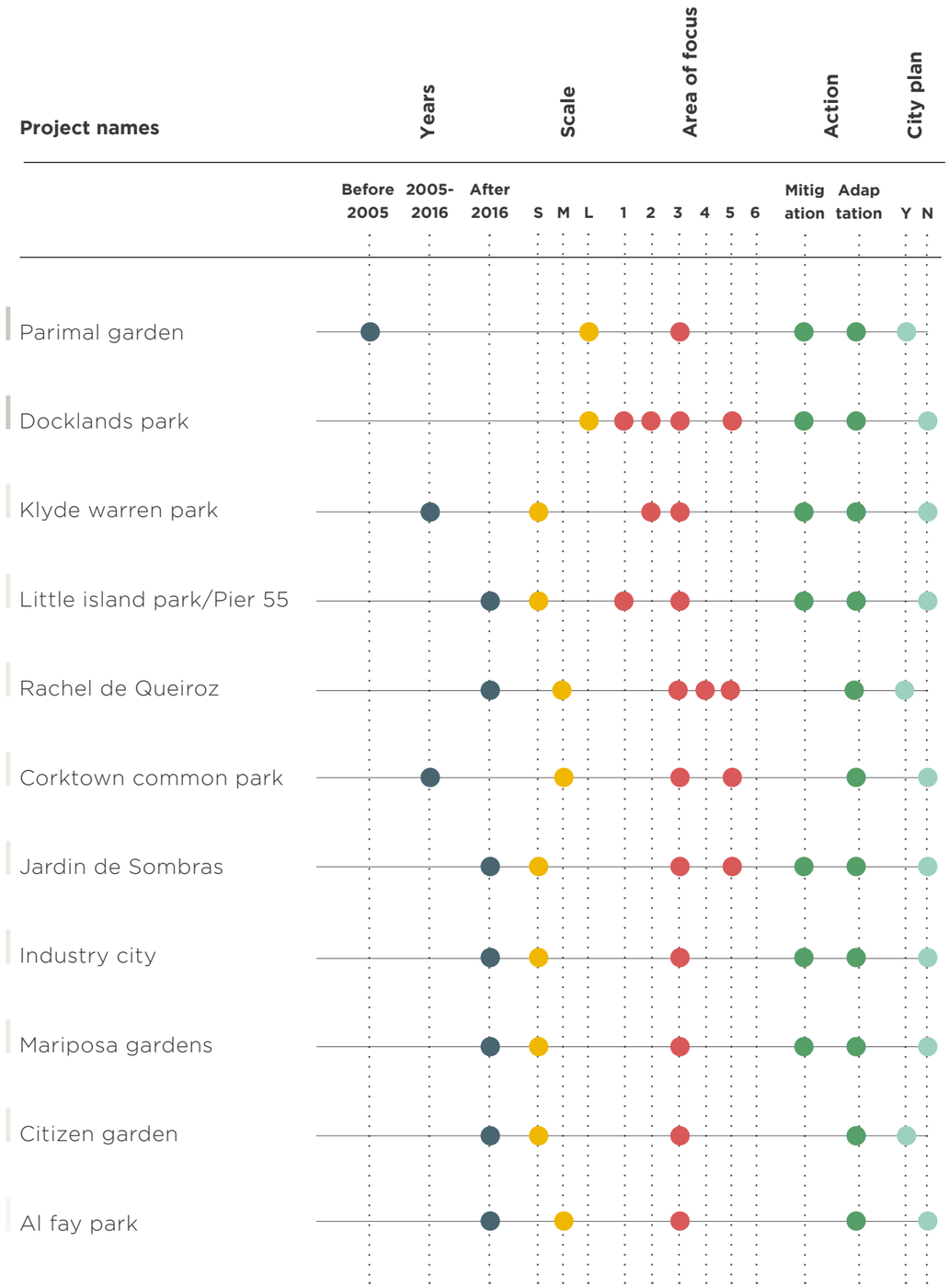
For the matrix area of focus were classified into six categories which contains different aspects of urban planning that were targeted in the climate change adaptation.

Area of focus
1 - Buildings and energy
2 - Transportation and land-use
3 - Water and natural system
4 - Consumption and waste
5 - Community resilience and adaptation
6 - Municipal plan and policy


Project names
Years
Scale
Area of focus
Action
City plan
Before 2005
2005-2016
After 2016
S
M
L
1
2
3
4
5
6
Mitigation
Adaptation
Y
N
Climate district in Østerbro
Valdocco redevelopment
Superblock
The south harbor
Jardin des joyeux
Pedagogic urban garden
Mayfield park
Elsa eschelsson's park
Atoms
Comm. courtyards
Konard-Adenauer-Platz


Project names
Years
Scale
Area of focus
Action
City plan
Before 2005
2005-2016
After 2016
S
M
L
1
2
3
4
5
6
Mitigation
Adaptation
Y
N
Strindfjordvegen park
World horticulture expo
Rada torg
Postpark
Urban campus leiven
Shoreline park
Rooftop park
St. Stephen's green park
Bryggens bastion
Centenary park
Undulating garden


Project names
Years
Scale
Area of focus
Action
City plan
Before 2005
2005-2016
After 2016
S
M
L
1
2
3
4
5
6
Mitigation
Adaptation
Y
N
Erhai lake
Green neighbourhood
Napier street open space
Donghu park
The mula mutha project
Jingkai central park
Bahadur shah park
Udhyan pravah
Victoria garden
Samnvay - workspace gar.
Timba basalt quarry


Project names
Years
Scale
Area of focus
Action
City plan
Before 2005
2005-2016
After 2016
S
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4
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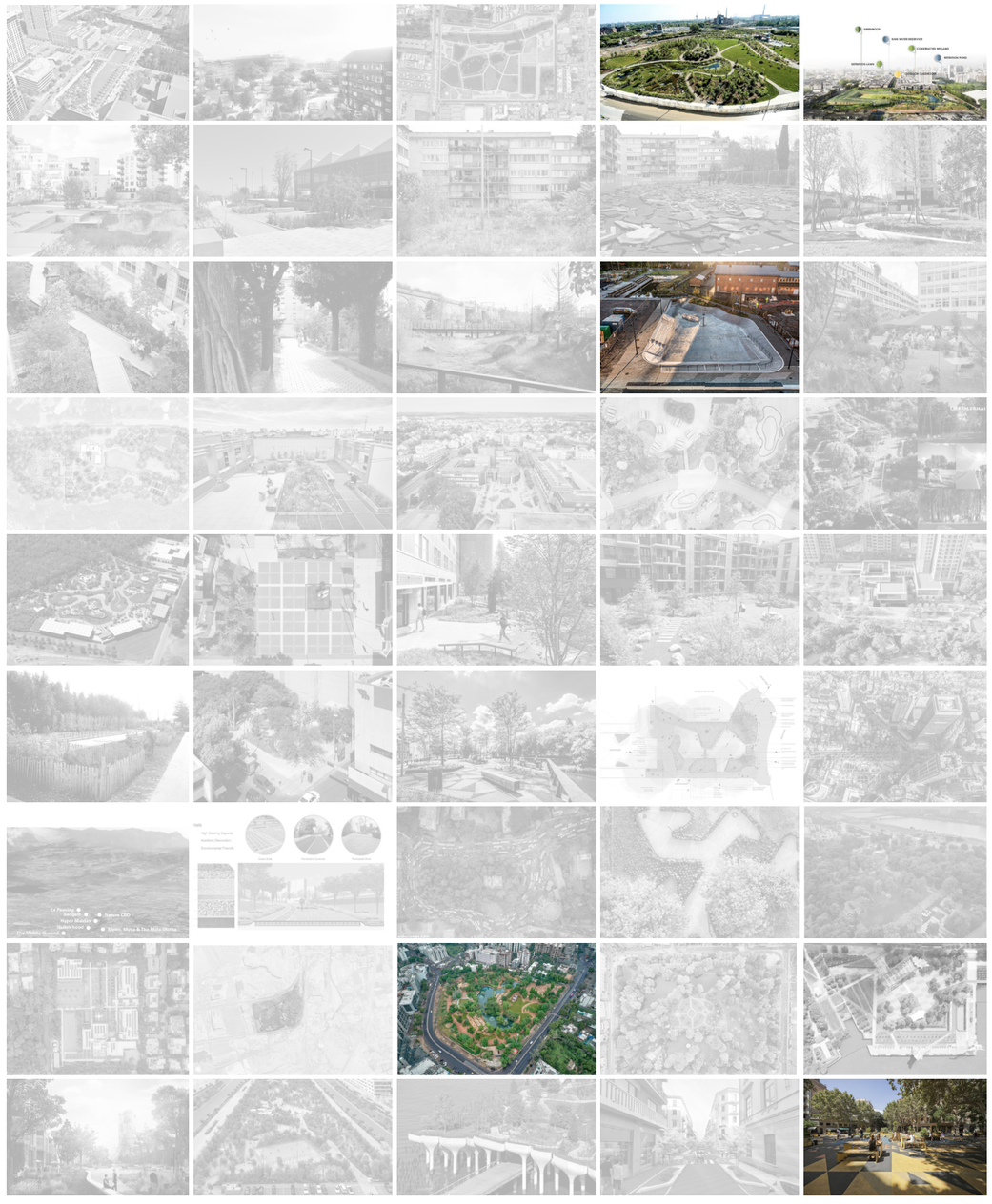
6
Mitigation
Adaptation
Y
N
Parimal garden
Docklands park
Klyde warren park
Little island park/Pier 55
Rachel de Queiroz
Corktown common park
Jardin de Sombras
Industry city
Mariposa gardens
Citizen garden
Al fay park

3.4.



Case studies |
Detailed analysis of five case studies

Based on the gathered research data about all case-studies and comparison matrix, 5 of the total case studies were identified to carry out in-depth analysis with consideration that the identified cases are supporting the research questions as well as objectives and further provide elaborate understandings of the topic. These 5 cases to be studied in detail were identified based on multiple dimensions, firstly, inclusive of their applicability in accordance with their location having unique geographical, social, and environmental context which plays a major role in defining their uniqueness and exhibit distinctive characteristics. Secondly, having different spatial scales in order to have insight about scale of its influence and to understand the implementations of small to large scale local initiatives and the way they emulate the benefits on upper scales. Additionally, the climate impact addressed while planning and designing the specific public spaces was also considered to understand the nature of different climatic issues in diverse context to have a broader perception of the subject. Lastly, the distinctive methodology used in dealing with particular climatic issue was also the main criteria while selecting the cases to be examined thoroughly, which comprises various strategies and approaches to effectively adapt the given public spaces against climate change. Overall, the chosen subset of case studies was analyzed based on their information and the exceptional outcomes in order to extract the important and efficient design strategies that further can be used in the final section of the research thesis about designing and planning the specific case of public space to adapt it against climate change.

Case-study - 01

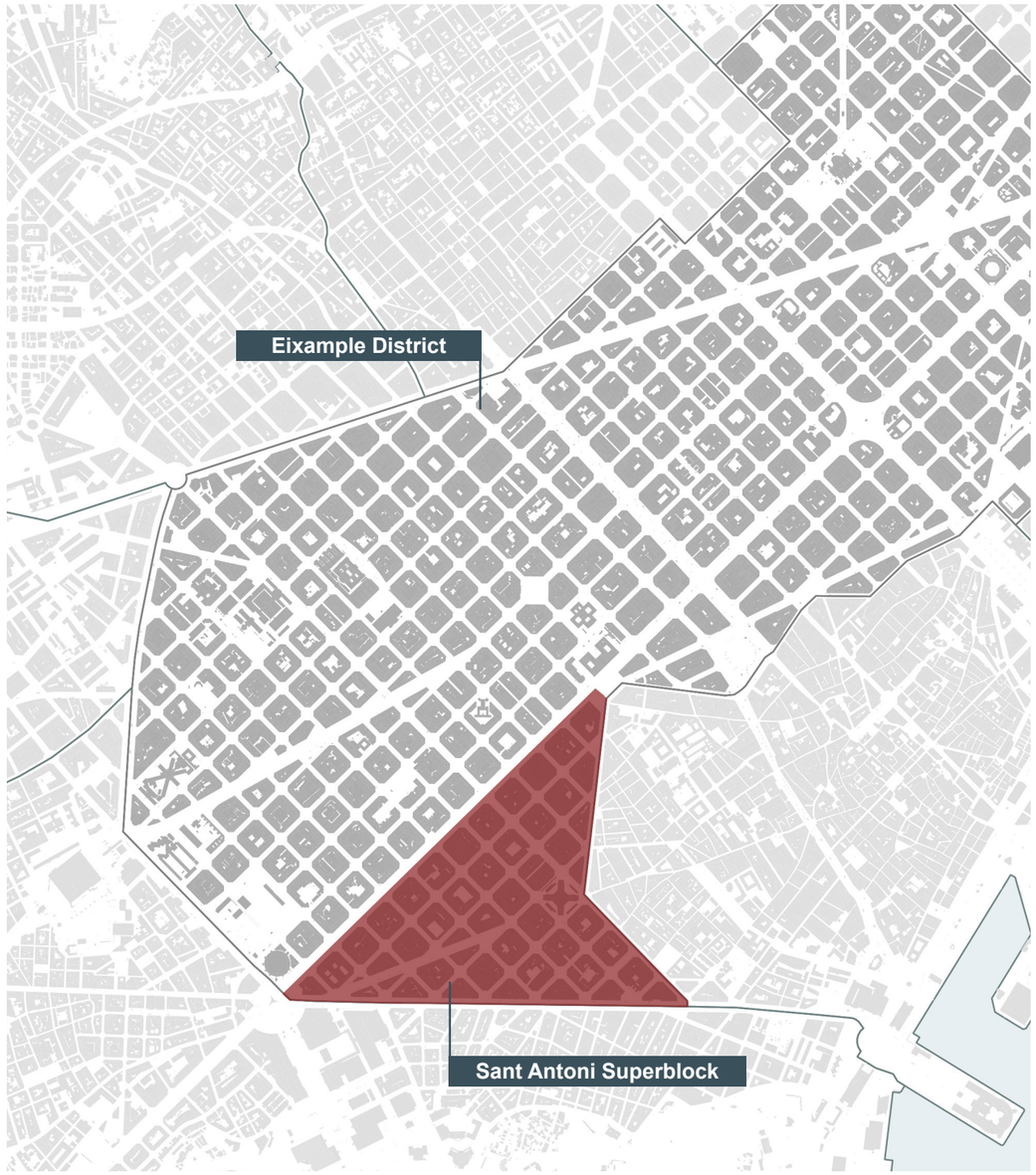


Figure 21 - Sant Antoni Superblock | Barcelona
Source: Author's elaboration

Superblocks | Barcelona

Year - 2005 and onwards
Location - Barcelona, Spain (Europe)
Spatial Scale - Large
Climate impact addressed - 2, 3, 5, 6 | Pedestrian centric neighborhoods, transportation emissions and Urban heat island effect
Action - Mitigation and Adaptation

Background

Together with urbanization and population growth, the city of Barcelona was facing various critical urban issues, including high levels of air pollution, noise pollutions, and increasing number of cars leading to the problems of traffic congestions. Additionally, the lack of green spaces was another major issue due to dense urban fabric of Barcelona with having narrower streets, which was compounding the problems related to climate change with rising temperatures and urban heat islands, affecting the quality of life of the residents and causing major health as well as environmental issues. Consequently, it led to deliberate about more sustainable development of Barcelona along with decreasing city's carbon footprint and enhancing the overall urban environment. Salvador Rueda who was the director of Barcelona Urban Ecology Agency along with Barcelona city council developed the concept of 'Superblocks' to deal with urban as well as environmental challenges and make it more sustainable and climate resilient.

The aims and objectives

The main idea behind Superblock project was focused on innovative urban planning strategy of regenerating the city in order to adapt it to the current context and modern challenges of social, environmental, and economic aspects. Superblocks, which are usually a grid of nine blocks, considers sustainable way of transformation which includes rebuilding the public spaces, improvising neighborhoods sustainable mobility and enhancing economy by reducing the consumption of natural resources, promoting greenery everywhere in the city to deal with climate crisis and improve the quality of life for citizens (Pla-Superilla-Barcelona , 2021). It promotes the transformation of public spaces across the city to facilitate places to meet others, revive local economies, improve lifestyle of neighborhood and incorporate the city with more greener areas in order to adapt these public spaces to climate change and linking people with nature (Barcelona Superblock| Barcelona City Council). One of the main goals of this project included reducing the greenhouse gas emissions as well as improving the air pollution by prioritizing the sustainable modes of transportation such as cycling and walking, reducing the vehicular emissions in the city of Barcelona. Further, the addition of green spaces and establishing their network through the means of different public spaces within the superblocks was aimed at combating the urban heat island effect by also reducing usage of the heat absorbing materials such as concrete and asphalt, while carefully designing the public spaces and streets-capes. Additionally, it was also focused on promoting the urban biodiversity with having the concept of Superblocks developed on the framework of

‘Ecological Urbanism’, henceforth, helping in adapting these public spaces as well as city against the challenges of climate change and accelerating the path towards more sustainable and climate resilient Barcelona.

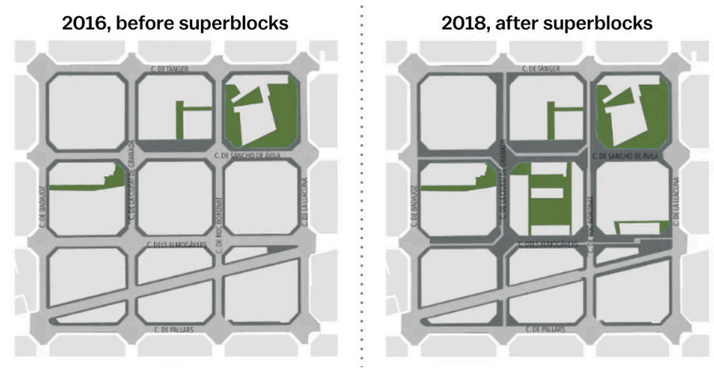


Fig 22. Barecelona Superblocks.
Roberts, D. (2019, April 9). Barcelona, Spain, urban planning: what the city learned from the first superblocks. Vox. Retrieved December 1, 2023, from https://www.vox.com/energy-and-environment/2019/4/9/18273894/barcelona-urban-planning-superblocks-poblenou

Fig 23. Ariel view of Barcelona.
GmbH, W. Stock Photos & Royalty-Free Images - Premium Image Agency. Westend61 GmbH. Retrieved December 1, 2023, from https://www.westend61.de/en/

The design

Superblock of Sant Antoni, which is located in the district of Eixample in Barcelona, is one of good instance of this project, consisting of developing the public space around market of Sant Antoni and further evolving the streets in the surrounding area. This specific case was focused various urban innovation to dealt with multiple urban challenges with the establishment of the pedestrian areas, green spaces and live spaces by reducing the traffic which can substantially help in reducing emissions, improve air and noise pollution, making environment friendly neighborhood that helps in dealing with rising temperatures. Moreover, it was aimed designing public spaces that engage community with multiple uses it offers and promote social cohesion and resilience (Superilla de Sant Antoni | Superilles). Overall, the Superblock project has a goal to deal with multiple urban challenges and adapting cities against the climate change through the means of public spaces and network of green spaces by prioritizing sustainable way of transformation which helps in reproducing the positive effects at multiple scales.

Fig 24. Superblock of Sant Antoni.
Caballero, P. (2023, March 6). Superblock of Sant Antoni / Leku Studio. ArchDaily. Retrieved December 1, 2023, from https://www.archdaily.com/938244/superblock-of-sant-antoni-leku-studio

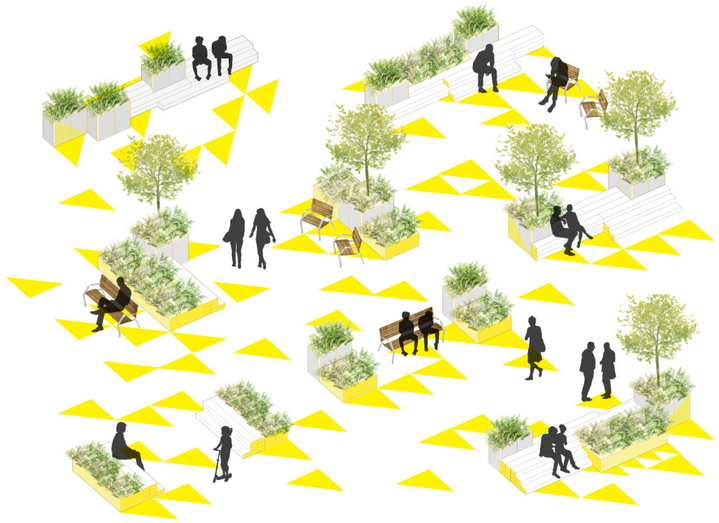


Fig 25. Superblock of Sant Antoni.
Caballero, P. (2023, March 6). Superblock of Sant Antoni / Leku Studio. ArchDaily. Retrieved December 1, 2023, from https://www.archdaily.com/938244/superblock-of-sant-antoni-leku-studio

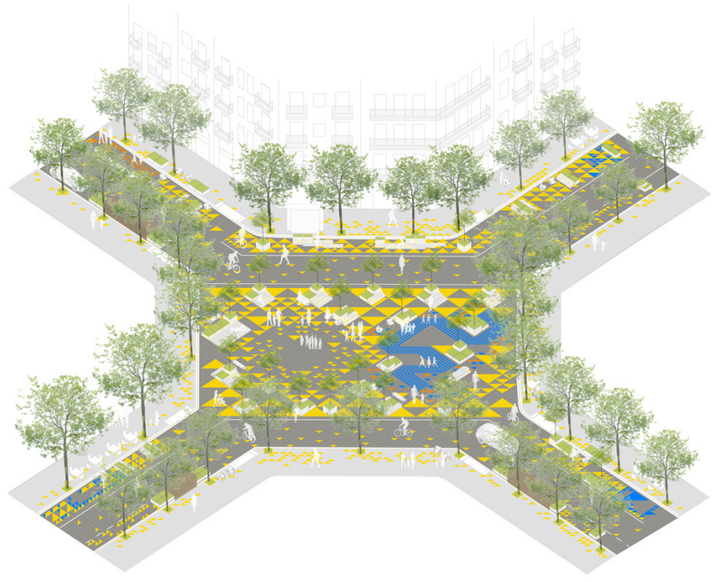


Fig 26. Superblock of Sant Antoni.
Caballero, P. (2023, March 6). Superblock of Sant Antoni / Leku Studio. ArchDaily. Retrieved December 1, 2023, from https://www.archdaily.com/938244/superblock-of-sant-antoni-leku-studio

The results

The Superblock program of Barcelona is an effective initiative that is aimed to modify various facets of urban environment, including general objectives of urban greening, sustainable transport, enhanced utilization of public spaces as well as community engagement in the overall planning process (Zografos et al., 2020). As a crucial urban infrastructure, Superblocks provide greater benefits in dealing with the climate change by reducing the greenhouse gas emissions, addressing urban heat island effect as well as providing more green public spaces in urban areas, making it significant instrument for improving mobility and enhancing the quality of life of the people while also helping in adapting the city against climate change (López et al., 2020). The implementation of these Superblocks in different neighborhood of Barcelona has effectively reduced the air and noise pollution, and has significantly improve the quality of public spaces which are more people and environment centric. With the strategies of incorporating more pedestrian and cycle friendly streets, it has notably helped in improving well-being of people. This potent initiative along with its combined adaptation and mitigation measures towards climate change have reproduce its benefits from local scale to more bigger scales. Overall, the Superblock program in Barcelona has successfully made Barcelona in forefront against the fight with the climate change, making it lucrative urban planning model for making cities more sustainable, climate resilient and human centric.

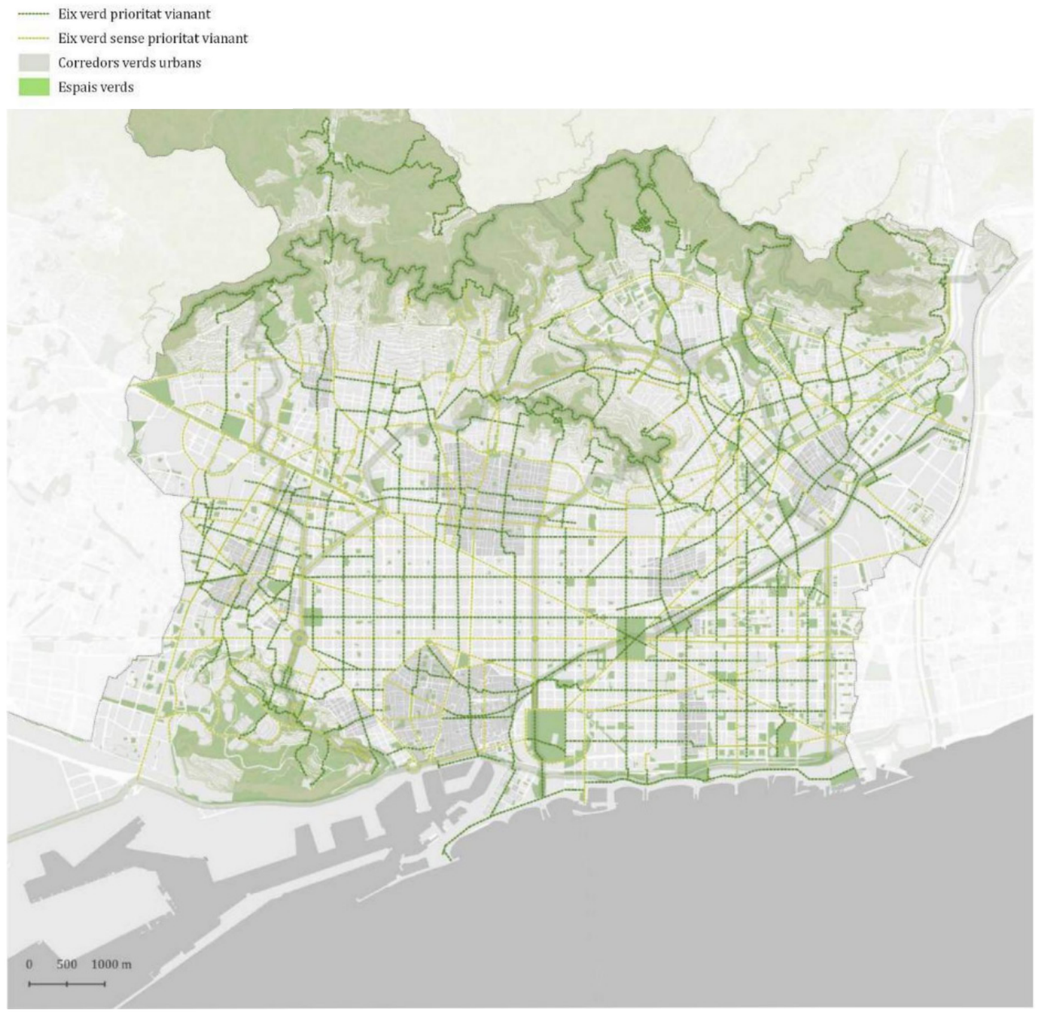


Fig 27. Green axis planned in Barcelona Superblocks program.
barcelona.cat/pla-superilla-barcelona MESURA MESURA DE GOVERN DE GOVERN SUPERILLA SUPERILLA BARCELONA BARCELONA PER REGENERAR PER REGENERAR BARCELONA BARCELONA I ELS SEUS I ELS SEUS BARRIS BARRIS. (2021).

Case-study - 02

Figure 28 - Corktown Common's Park **|** Toronto
Source: Author's elaboration

Corktown common park **|** Toronto, Ontario

Year - 2013
Location - Toronto, Canada (North / Latin America)
Spatial Scale - Large
Climate impact addressed - 3, 5 | Flood resilience, Various ecosystem services in the park
Action - Adaptation

Background

Being located beside the major water bodies of Don River and Lake Ontario, the city of Toronto has a rich industrial past and the Corktown Common Park is the post-industrial west Don lands just by the Don River. The site was an ecologically active marsh that was helping in absorbing the high levels of water, however, industrialization disrupted the physical foundation of the land with extravagant paving, filling as well as armouring which further increased the issues of pollution. Nonetheless, the decline of industrial activity in the late twentieth century made the site of the current Corktown Common Park as a brown-field with many challenges which sternly needed to be restored. Additionally, the location of the site was such that it was extremely exposed to the flooding of the Don River, which could potentially immersed 210 hectares of Toronto. Thus, WaterfrontTORONTO along with City of Toronto decided to revitalize the industrial site and to deal with environmental issues which was designed by the Micheal Van Valkenburgh Associated (MVVA) with an ambitious aim of sustainability for the urban development.

The aims and objectives

The Corktown Common project was considered to be an essential factor for the future sustainability pathway of Toronto city with the goal of enhancing quality of life, community well-being, environmental benefits as well as to deal with current challenges of climate change, becoming a global instance of sustainable urban development by prioritizing environmental and social responsibility. The primary objective was to establish an efficient and robust natural area that integrates with built environment and also combat current environmental concerns (Magnusson et al., 2023). It was aimed to be developed with the strategy to construct flood resistant infrastructure and designing a public space that is both environmentally and culturally affluent, where bio-diverse ecosystem will proliferate and self-sustain (Corktown Common | Biennal). Furthermore, the design of the park was intended to create a sustainable urban landscape that is anchored in natural systems along with introducing widespread recreational activities for the citizens, creating a neighborhood park that engage the community. Indeed, the park was designed with a vision of reducing emissions, functions diligently, and using sustainable materials, making the urban landscape as crucial component of urban development and focusing on the demand with the intricate connection between urban and natural areas (Magnusson et al., 2023).

Fig 29. Corktown Common Park.
Corktown Common: Building Community Resiliency with a Neighborhood Park | Biennal. Retrieved December 1, 2023, from https://landscape.coac.net/en/node/2134

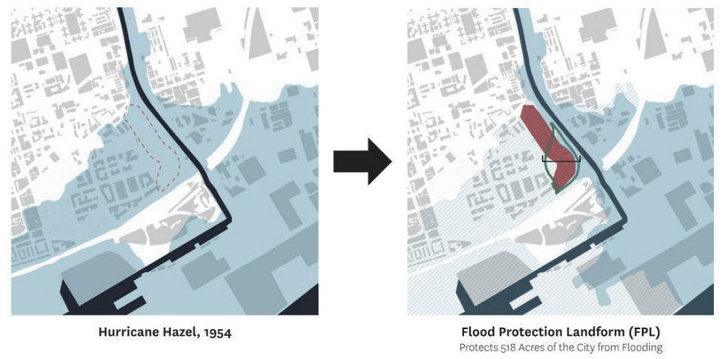


Fig 30. Flood plain and section.
Corktown Common: Building Community Resiliency with a Neighborhood Park | Biennal. Retrieved December 1, 2023, from https://landscape.coac.net/en/node/2134

The design

Corktown Common, which was envisioned as a critical development of public infrastructure to mitigate the floods in the beginning, was finally planned and designed with the combination of neighbourhood park along with flood protection land. Earthen terrain of 13 foot high in parallel to the Don River redefines the floodplain, causing the water to flow towards south into the Lake Ontario, with having Corktown Common Park sitting on the top of this infrastructural element as mesmeric recreational urban landscape (Michael Van Valkenburgh Associates Inc | Corktown Common). The imperatives of building raised terrain extended intriguing landscape opportunities for exciting panoramas of the city, with the landforms sloping away from the high point with a shallow slope, offering a vibrant sheltering condition allowing a range of micro-climates habitat. The extended barrier divides the park into two naturally and functionally distinct portions of inundation area and protected area (Corktown Common | Biennal). Grass-covered landscape on the park's east side is planned to be flooded, providing soft and resilient edge to the river. While the west side of the park is high and intended to be protected, with having diverse functional, ecological, and spatial features. It consists of outdoor areas for citizens to enjoy the green public space with carefully planned nature and activities, along with the built marsh which collects the rainwater to irrigate the park and saves considerable amount of water during the peak season (Michael Van Valkenburgh Associates Inc | Corktown Common). Additionally, considering regenerative ecology was crucial while designing the park, thus, sizable amount of soil was used to provide habitat for migratory birds, pollinators, and other wildlife. The native Ontario plants were used in the park which stimulate self-seeding of native perennials along with the facilities of organically maintain the park. Moreover, the water from the splashpad created for people to enjoy is treated and diverted to help preserve the marsh while also delivering irrigation. Extra water is stored in an underground tank to be used during the peak seasons. Overall, with all efforts and strategies implied in the planning and designing of the park deliver a very efficient system and allow the Corktown Common Park to convert into a sustainable natural ecosystem (Corktown Common | Biennal).

Fig 31. Site plan of Corktown Common Park.
Corktown Common: Building Community Resiliency with a Neighborhood Park | Biennal. Retrieved December 1, 2023, from https://landscape.coac.net/en/node/2134

The results

Substantially, the site of Corktown Common Park has seen remarkable transformation from a former brown-field to a current dynamic urban park, including green open space, abundant diversity of plants and countless trees, green open spaces, as well as meadowland walkways. Besides from its main purpose of serving as a flood protection land and recreational attraction, the park also suffices as an educational urban infrastructure which attracts various government and industrial organizations as well as universities. As a cherry on the top, the well-designed park of Corktown Common also generates micro-climates that sustain biodiverse ecology, attracting migrating birds and provide recreational activity such as skiing during the winter along with its built flood protection terrain. Moreover, the area has an investment of thousands of dollars along with the addition of residential units which has stimulated the revenue generation and growth of the city, which further lays the groundwork for the future for urban ecological growth with amalgamation of engineering, renewal and landscape strategies (Corktown Common | Biennal).

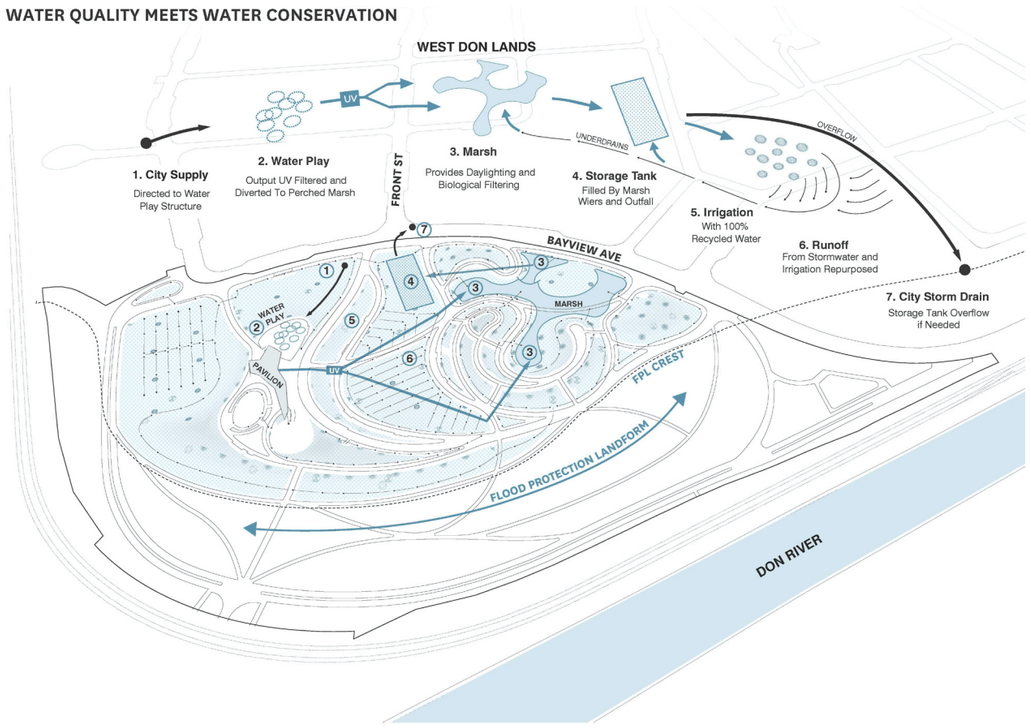


Fig 32. System of stormwater.
Corktown Common: Building Community Resiliency with a Neighborhood Park | Biennal. Retrieved December 1, 2023, from https://landscape.coac.net/en/node/2134

Case-study - 03

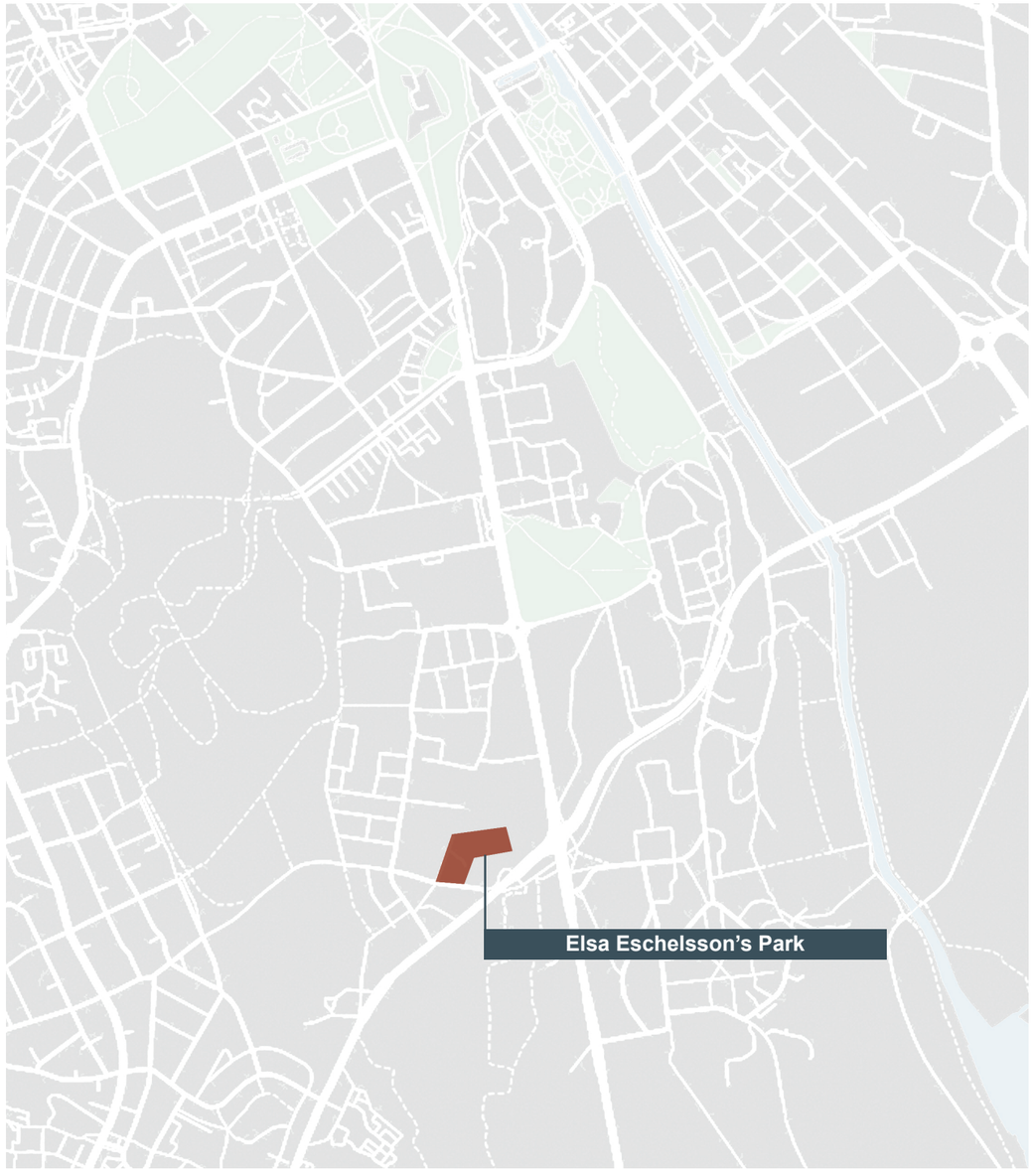


Figure 33 - Elsa Eschelsson's Park | Rosendal
Source: Author's elaboration

Elsa Eschelsson's Park | Rosendal, Sweden

Year - 2022
Location - Rosendal, Sweden (Europe)
Spatial Scale - Small
Climate impact addressed - 3, 5 | Storm-water management, Related to manage rain water
Action - Adaptation

Background

Being located beside the major water bodies of Don River The Elsa Eschelsson's Park is located in Rosendal, which is new and smaller district in Uppsala, Sweden. This new area of Rosendal in Uppsala, has been strategically planned in order to make it environmentally efficient and sustainable with an emphasis on innovation as well as climate neutrality aiming to increase the ecosystem services, biological diversity, sustainable storm-water management, managing air, noise, and temperature quality with more natural and green spaces (Uppsala Växer). Along with the densification of the city, the specific attention has been given to the sustainable storm-water management by considering the green-blue storm-water system in order to deal with the issues of drought, pollution, flooding caused by rapid surface runoff water, scarcity of green public spaces, urban heat island effects, and other challenges related to the environment (Uppsala Växer).

The aims and objectives

With a discrete characteristic of an innovative and sustainable storm-water management system, the Elsa Eschelsson's Park has been designed in the year of 2022 by Karvan landscape architecture office with Uppsala Municipality. Considering the unique location of Rosendal on the ridge, the main purpose of this development was to build a system that cleans water and delay the process by initially purifying it in vegetated areas as well as reservoirs in urban areas and later in the lakes which can assist in controlling the flood during the heavy rain by letting the water flood where it does not cause any damage (Uppsala Växer). Additionally, another goal of this project was to utilize the site in highest possible way by creating an innovative multipurpose place which can act as a green public space when it is not raining, where people can enjoy various activities while also observing the process of storm-water management (Uppsala Växer).

Fig 34. Activity area.
Elsa Eschelsson's Park by Karavan landskapsarkitekter. Landezine. Retrieved December 1, 2023, from https://landezine.com/elsa-eschelssons-park-by-karavan-landskapsarkitekter/

Fig 35. Activity areacollecting water.
Elsa Eschelsson's Park by Karavan landskapsarkitekter. Landezine. Retrieved December 1, 2023, from https://landezine.com/elsa-eschelssons-park-by-karavan-landskapsarkitekter/

The design

The Elsa Eschelsson's Park has been designed in a unique way to be functional in multiple ways, as the green public space for people to enjoy different activities which can be flooded in the season of heavy rains. The park is divided into three sections, including an activity area, a stormwater pond and a green park, which integrates the storm-water in all of its part with having collection area in storm-water pond and visual illustration of rain on hard surfaces in order to demonstrate the course of storm-water in the urban settings (Elsa Eschelsson's Park | Landezine). The activity area of the park is designed as a sunken hard surface with gradual slopes, constructed in cast-in-place concrete, that facilitates multiple recreation activities such as biking, skating, as well as basketball, while also operating as a dense surface that delays the rainwater. A storm-water pond in the center of the park is designed carefully to not with features such as the dam with retaining walls, steps as well as piers on both west and north side in order to increase the amount of water to retain and it extends towards the activity area during the period of heavy rain. The north side of the park includes walkways as well as large pier with steps and seating arrangements for gatherings with having more sunlight. Whereas, the south side have green slopes which allows the wildlife and aquatic plants to habitat. Moreover, during the time of excess rainfall the water from the dam is extended towards the green area, where the water can organically slow down and penetrate into the ground in order to maintain the groundwater and the plantings of native shrubs and trees in southern part of the park acts as a link between the green slopes of the with the neighboring park. However, this area of the park with grass is designed to accommodate various recreation activities for the citizens during other time of the year (Elsa Eschelssons Park | Karavan Landskap).

Fig 36. Stormwater pond.
Elsa Eschelsson's Park by Karavan landskapsarkitekter. Landezine. Retrieved December 1, 2023, from https://landezine.com/elsa-eschelssons-park-by-karavan-landskapsarkitekter/

Fig 37. Stormwater pond.
Elsa Eschelsson's Park by Karavan landskapsarkitekter. Landezine. Retrieved December 1, 2023, from https://landezine.com/elsa-eschelssons-park-by-karavan-landskapsarkitekter/

The results

The design of the park has successfully help in adapting to the periods of heavy rainfall along with providing natural public space in the urban area for the people where they can connect with nature as well as get familiar with the process of sustainably managing the storm-water. The park serves as a green-blue infrastructure with having vegetated areas as well as areas where the water is managed, helping in mitigating the flood as well as in generating biodiversity withing the urban fabric which provides habitat for wildlife, create better living environment in the city and serve as a place for the engagement of the community (Uppsala Växer). Overall, it is sustainable model of multi-functional public space which is helping in making urban development within Uppsala more sustainable and climate resilient.

Fig 38. Elsa Eschelsson's Park.
Elsa Eschelsson's Park by Karavan landskapsarkitekter. Landezine. Retrieved December 1, 2023, from https://landezine.com/elsa-eschelssons-park-by-karavan-landskapsarkitekter/

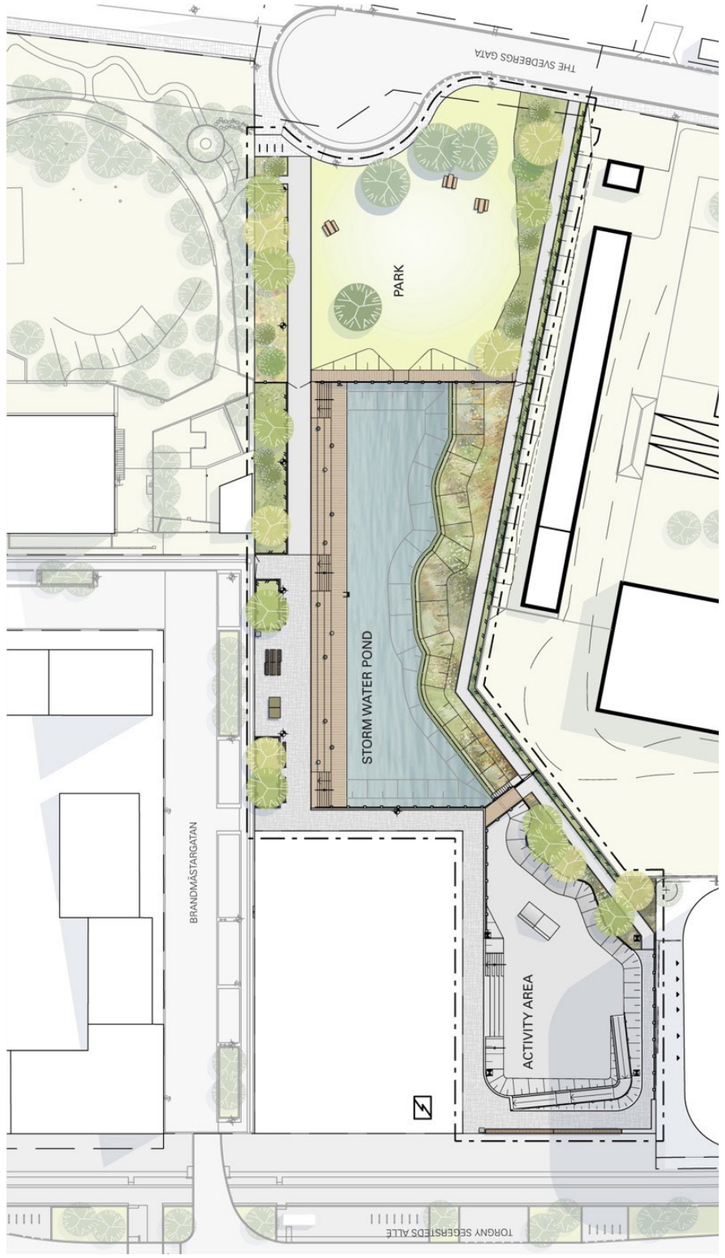


Fig 39. Plan of Elsa Eschelsson's Park.
Elsa Eschelsson's Park by Karavan landskapsarkitekter. Landezine. Retrieved December 1, 2023, from https://landezine.com/elsa-eschelssons-park-by-karavan-landskapsarkitekter/

Case-study - 04

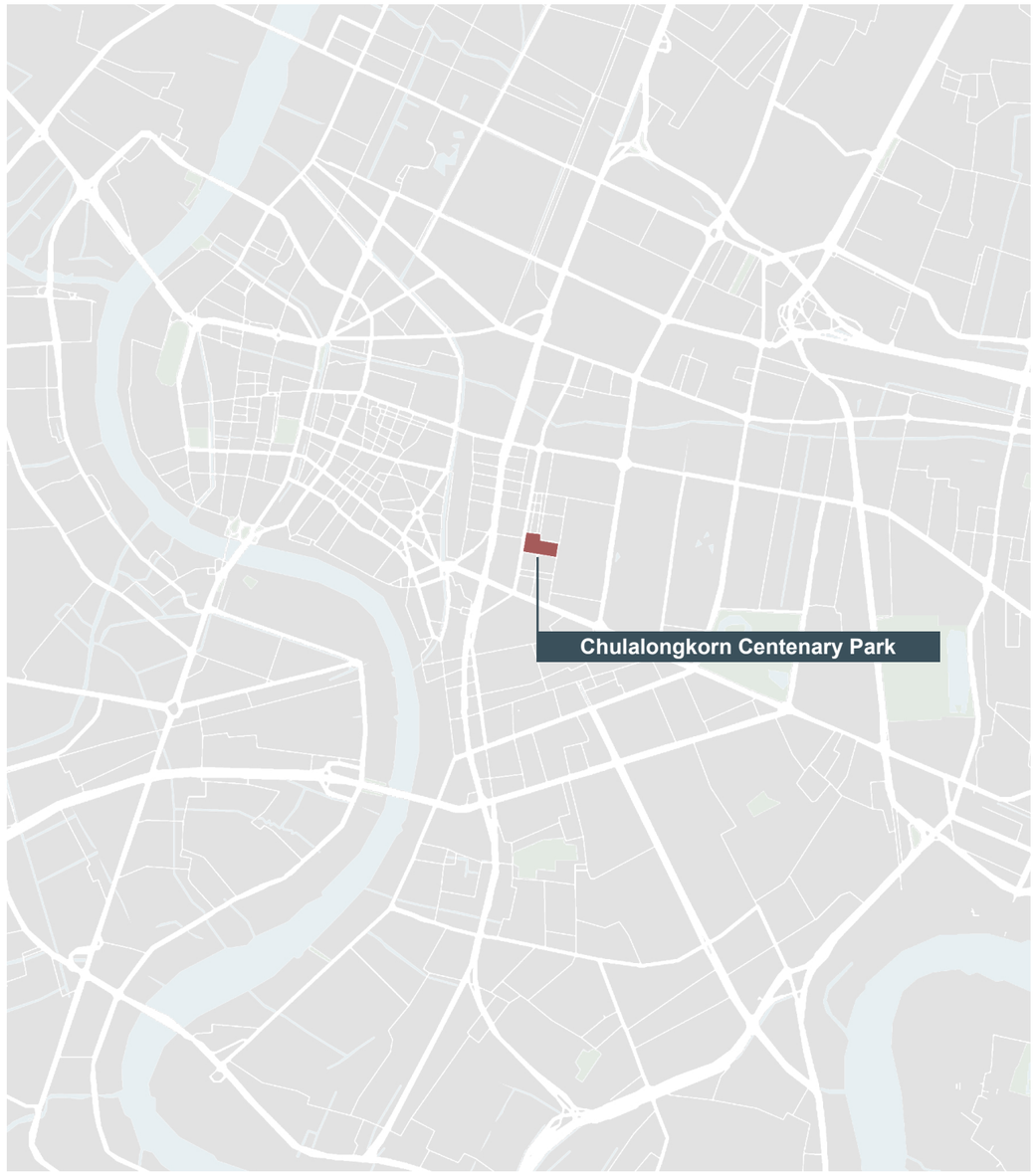


Figure 40 - Chulalongkorn Centenary Park | Bangkok
Source: Author's elaboration

Chulalongkorn Centenary Park | Bangkok

Year - 2019
Location - Bangkok, Thailand (Asia/Pacific)
Spatial Scale - Medium
Climate impact addressed - 1, 2, 3, 5 | Flooding issues in an urban areas, Helping in UHI as a green urban space
Action - Adaptation and Mitigation

Background

The Chulalongkorn Centenary Park is located in the centre of commercial area of the Bangkok city. Over the last few decades, Bangkok has significantly urbanized making it more vulnerable to the effects of climate change. Consequently, the city has become less permeable as urbanization has taken over the agricultural areas which previously served to handle the flooding as well as heavy rainfalls, which has also increased the issues related to flooding, higher temperatures, and poor water management. Additionally, Bangkok is situated at a low elevation which makes it more exposed to the risk of sea level rise and severe storm surges (Damian Holmes, 2019). Furthermore, the urban development has resulted in scarcity of green public spaces, making it grey city. Thus, the government has started implementing the strategies of urban planning in order to adapt the concept of green city at the local level which considers various aspects of land use planning, green space network, waste and water management, as well as energy efficiency to quickly adapt the city against the climate change through these local initiatives and lead it towards more sustainable and resilient city (Yarnvudhi et

al., 2021). In accordance to these policies and urban planning strategies, the Chulalongkorn Centenary Park was designed as a crucial green infrastructure, providing green public space in the grey city of Bangkok and to help counteract the negative environmental concerns.

The aims and objectives

In line with the green city project of Bangkok, the Chulalongkorn University Centenary Park was designed on the land of 11 acres in order to deal with the unpredictable future of climate change, with a main focus on coping with significant ecological issues of flooding, water management and urban heat island effect that the city of Bangkok if facing in the current times. Additionally, the park is designed to act as recreational green public space for the people of city along with being productive piece of land to confront the climate change. The primary goal was to develop a park capable of collecting, treating, and retaining the water in sustainable way in order to minimize the flood hazards in the surrounding neighborhoods (Parque Centenario de La Universidad de Chulalongkorn | Biennal). The efforts were also made towards improving the roads connecting the park by reducing the vehicular access and making it more pedestrian and bicycle friendly which can help in reducing the emissions as well as enhancing the quality of life of people. Overall, the Chulalongkorn University Centenary Park was planned with an aim of creating the urban forest in the dense urban fabric of the Bangkok city that can act as an active public space which is competent to deal with environmental challenges the city is facing as well as to provide a better green area for the citizens to connect them with nature while surrounded by the greyness of the city, helping in adapting the city of Bangkok faster against the global issue of climate change, more resilient and sustainable model of urban development that can influence other cities towards their pathway of sustainability.

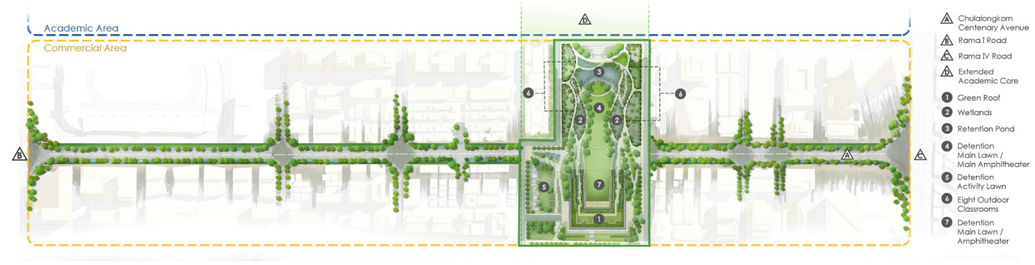
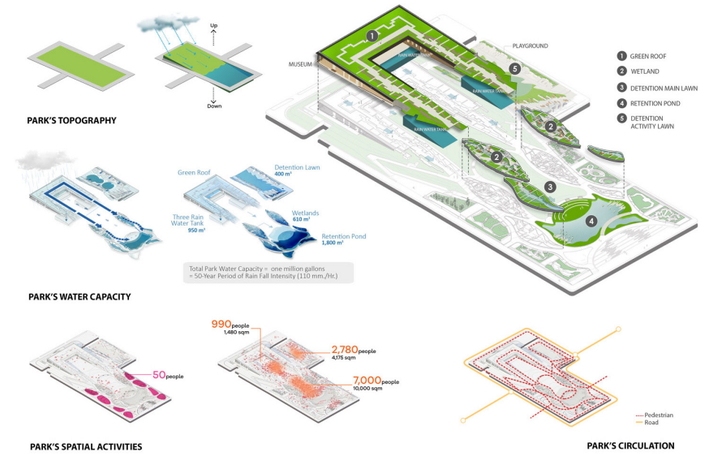


Fig 41. Masterplan of Chulalongkorn Centenary Park.
Chulalongkorn University Centenary Park « Landezine International Landscape Award LILA. Retrieved December 1, 2023, from https://landezine-award.com/chulalongkorn-university-centenary-park/

Fig 42. View of park in the middle of dense urban fabric of Bangkok.
Chulalongkorn University Centenary Park « Landezine International Landscape Award LILA. Retrieved December 1, 2023, from https://landezine-award.com/chulalongkorn-university-centenary-park/

The design

The Chulalongkorn Centenary Park is designed to ensure that maximum ecological benefits can be generated, with integrating strategic features including wetlands, detention areas, a storage pond as well as green roofs. With having a gradual slope of 3 degree, the park allows the rain and runoff water to flow down by means of its terrain which can produce an adequate water circulation system. The green roof of the park is the topmost part of the site, which is accessible by everyone having the panoramic views of Bangkok skyline along with its green grass attracting indigenous birds and insects. This roof is designed to let the rainwater penetrate in it which is then stored in the underground water tanks which is capable storing the volume of water that is enough to irrigate the whole park. Additionally, the four wetlands are built on each side of the park which receives the excessive water from the green roof with having the native plantation, which helps in treating the water. A retention pond, serves as a water storage at the lowest point and during the intense flooding it expands towards the main lawn. Apart from its environmental benefits, the park is designed with various activities for the well-being of the people, which include meditation areas, playgrounds as well as herb gardens. The numerous amounts of trees have been planted which are capable to adapt faster to the changing climate and help dealing with urban heat island effect in the urban area, making the park act as an urban forest. Indeed, the park is designed to incorporate diverse favourable results in environmental and social aspect (Chulalongkorn University Centenary Park « Landezine).



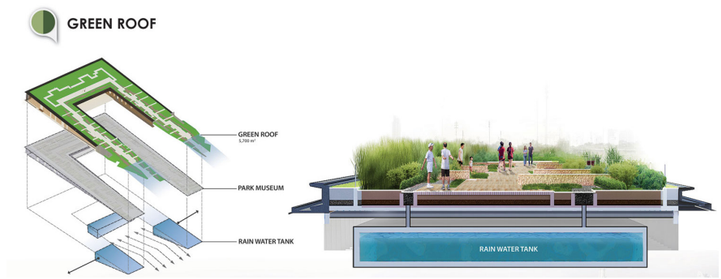


Fig 43. Various design elements of park. Chulalongkorn University Centenary Park « Landezine International Landscape Award LILA. Retrieved December 1, 2023, from https://landezine-award.com/chulalongkorn-university-centenary-park/

The results

As a green oasis, the well planned and developed Chulalongkorn Centenary Park in the dense urban fabric of the Bangkok have given multiple positive benefits to the environment as well as residents, generating a built environment where people and nature can co-exist. It has successfully provided various ecosystem services which are helping in managing flood, improving air quality, as well as enhancing the quality of life. Moreover, the on-site water management system with different features have been developed to be able to store millions of gallons of water in the period of heavy rainfall, which has effectively aided in mitigating the risk of floods in the city (Parque Centenario de La Universidad de Chulalongkorn | Biennal). Additionally, the park also provides various recreational activity areas which helps in engaging community as well as making them aware about the environment. The transformation of the roads along with park by incorporating pedestrian and cycle friendly pathways along with dense vegetation have helped in creating safe environment and creating better microclimates to deal with urban heat island effect. In general, the Chulalongkorn University Centenary Park serves as crucial model of green infrastructure in the dense urban area that is helping city faster towards making it more sustainable, resilient and climate conscious.

Fig 44 - Various design elements of park.
Chulalongkorn University Centenary Park « Landezine International Landscape Award LILA. Retrieved December 1, 2023, from https://landezine-award.com/chulalongkorn-university-centenary-park/

Fig 45. Retention pond in the park.
Chulalongkorn University Centenary Park « Landezine International Landscape Award LILA. Retrieved December 1, 2023, from https://landezine-award.com/chulalongkorn-university-centenary-park/

Case-study - 05

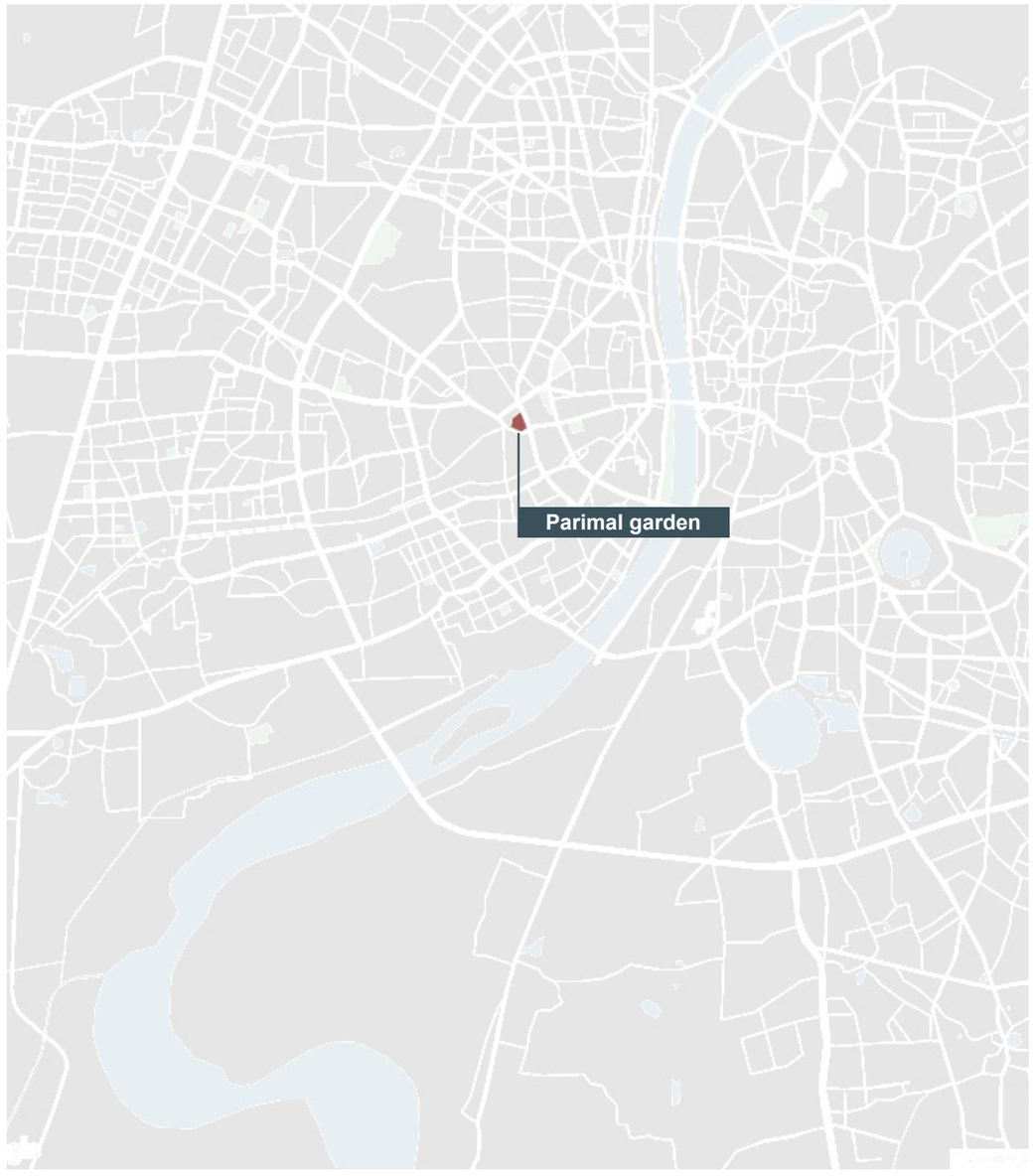


Figure 46 - Parimal Garden | Ahmedabad
Source: Author's elaboration

Parimal Garden | Ahmedabad

Year - Unknown

Location - Ahmedabad, India (Asia/Pacific)

Spatial Scale - Large

Climate impact addressed - 3 | Sustainable model of urban park in dense urban fabric of the city

Action - Adaptation and Mitigation

Background

The Parimal Garden is located in Ahmedabad city in the state of Gujarat in India. With having its importance emerging as one of the substantial trade and commerce center in western India during the beginning of twentieth century, it started facing the rapid urbanization and increased populations leading towards several environmental issues and increased scarcity of green open spaces in the city. However, the first mayor of Ahmedabad Municipal Corporation decided to build parks inspired from the west in order to incorporate a revitalized notion of the culture and community in the city. The Parimal Garden of today was an open green space near to the famous and important Law Garden (The Restoration of the Parimal Garden, 2023). Initially, the Parimal Garden was built in regards to the growing urban challenges which has further seen few redevelopments, becoming a crucial green space in the dense built fabric of Ahmedabad.

The aims and objectives

The Parimal Garden was planned on a vital land of the city with an aim of improving the urban environment and fostering sustainability. As its recreational function, the design of the garden was primarily focused on accessible, pleasant, and natural area for the neighborhood along with aspects of sustainability. Additionally, the plants and trees were carefully chosen which were native with a goal to enhance the aesthetics as well as to increase the ecological benefits. Overall, the garden was strategically planned in such way to be able to become a remarkable piece of land which improve the quality of life, provide a natural place, and generate multiple environmental advantages.

Fig 47. The pond inside the Parimal garden.
Landscapeindia. Retrieved December 1, 2023, from https://www.landscapeindia.net/projects/landscape-architecture/parimal-garden

Fig 48. Plan of Parimal garden (2020).
The Restoration of the Parimal Garden. (2023).

The design

The Parimal Garden has been designed with a focus on providing an environmentally sustainable green public spaces in the dense urban fabric for the citizens. Initially, the garden was planned during 1950s in a residential area on a low-lying land with having a old tree as a key component, with having various entry points in order to make it more accessible to the people. After densification of the area with the commercial activities, the garden was redeveloped with additional features lakes, gardens, and native plants to make it more adaptable to the changes in an urban environment. The dense vegetation is carefully designed and chosen in such a way that helps in improving air quality, reducing emissions, and dealing with so called urban heat island effect. The lily pond, lawns and other activity areas with native plants and trees together act in enhancing and preserving the biodiversity. Various recreational areas were also introduced in the design, including walkways, meditation area, play areas, amphitheater as well as walkways that helps in engaging community and provide multiple benefits to them (The Restoration of the Parimal Garden, 2023).

Fig 49 (Upper). Parimal garden in the city.
The Restoration of the Parimal Garden. (2023).

Fig 50 (Lower). Isometric view of Parimal garden (Ahmedabad).
The Restoration of the Parimal Garden. (2023).

The results

The Parimal Garden has continuously provided multiple benefits to the people and the environment since the beginning of its development. Firstly, the planning of this garden in the heart of Ahmedabad city has provided multiple benefits to the citizens by providing green public space in a heavily commercialised area and it has successfully survived all of its transformation. The plantation of native plants and numerous trees have significantly improved the air quality by reducing emissions and creating a natural buffer zone in the urban fabric. Various ecosystem services generated through this garden has help in mitigating higher temperatures and has provided comfort to the visitors. Additionally, the recreational activities have helped in connecting people more closer to the nature while also benefiting the wildlife. Overall, the Parimal Garden stands out as a great example of green public space in a dense urban fabric which can provide various advantages in order to adapt cities faster towards current challenges of urban areas and those related to climate change.

Fig 51 and 52. Parimal garden (Ahmedabad).
The Restoration of the Parimal Garden. (2023).

3.5.

Case studies |
Learning through case studies

The comprehensive analysis of numerous worldwide case studies, having various geographical and climatic context provide an invaluable insight about the significance of planning and designing of public spaces at the local scale in order to combat with the climate change. The utilization of a comparison matrix played a crucial role in recognizing the currently dominant climatic issues addressed in the planning of public spaces across the globe to adapt them against climate change by defining the category regarding climate change experimentation of the matrix into six major areas, such as buildings and energy, transportation and land-use, water and natural system, consumption and waste, community resilience and adaptation, as well as municipal policy. These six distinctive divisions revealed an insightful pattern by uncovering the prioritized concerns addressed in these global projects, which were mainly focusing on the two categories of transportation and land-use as well as natural and water system, helped in obtaining the major three set of issues that have been frequently being addressed in the planning and designing of the public spaces in recent times.

1) Thermal comfort
2) UHI mitigation
3) Storm-water management

These three major types of climatic issues outlined in the case studies all share the common objectives of alleviating overheating of urban areas, managing floods, improving air quality, and reducing greenhouse gas emissions in rapidly urbanizing world. Furthermore, an in-depth analysis of five selected case studies provided a detailed perspective regarding how public space planning is interconnected along with urban planning and climate change adaptation, assisting in the extraction of valuable design and planning strategies with a heterogeneous methods required in order to activate the public space to deal with the issues of climate change, enhance their performance in an urban area and further making cities climate responsive, resilient, and sustainable.

Extracted strategies

Flexible and Adaptable public spaces – Considering the uncertainties of climate change, it is required to plan and design public spaces that are flexible, modular and can evolve according to the altering climatic conditions in an urban area. Given case studies shows that flexibility and adaptability help in enhancing the performance of these public spaces and making it responsive towards various urban and climate related challenges.

Incorporating green-infrastructures and nature-based solutions – It is evident from the case studies that integrating green-infrastructures and nature-based solution into designing of public spaces effectively help in transforming them into climate-responsive public spaces. Utilizing elements such as green roofs, retention ponds, permeable materials, dense vegetation, rain gardens, and many more helps in managing water, balancing urban temperature, promoting biodiversity as well as creating better micro-climate across the urban areas along with enhancing the aesthetical appearance.

Increased vegetation – Several case studies show how implementing green spaces, dense vegetation and increasing number of trees in dense urban areas can significantly contributes in carbon sequestration, improving air quality, reducing the urban heat island effects, and providing better liveable spaces.

Sustainable mobility – Public spaces that are well-designed, promote walking and cycling can significantly contribute in reducing the greenhouse gas emissions. The case studies indicate this effective strategy of promoting sustainable transport in an urban area to improve the air quality and thermal comfort by considerable reduction in vehicular emissions which also improve the health of the people.

Community engagement and participation – The case studies reveal the fact that engaging community in decision-making and designing of the public space can effectively lead towards creating climate-adaptive public spaces that are more active.

Sustainable stormwater management system – The case studies illustrates the significance of sustainable stormwater management system in the designing of public spaces by incorporating elements such as rain gardens, infiltration trench, retention ponds etc. It effectively helps in managing the water which further reduce the challenges related to water including the risk related to floods.

PART III

DESIGNING PUBLIC SPACES

CHAPTER

04

CLIMATE CHANGE IN INDIA

4.1.

Climate change in India | Planning systems in India

The origins of the planning system in India lies in the ancient Indus Valley civilization, where the cities were carefully planned in the grid pattern in order to provide access, water as well as sewage to all the places. However, the current planning system in India developed in the early 20th century. During this time, the industrialisation gave rise to the clustering of the economic activities in and around the cities. Increased job opportunities started attracting many people to migrate towards the industrialised cities in order to take advantage of the economic opportunities. This uncertain growth in population and economic activities in cities led to the crowding, congestion and unhygienic situation which resulted in the need for the urban planning system to become the forefront.

Urban Planning and Development system in India is under the control of state governments which assign the respective responsibilities to the local municipal bodies as mentioned in the 74th Constitution Amendment Act. The Ministry of Urban Development (since 1985) which was renamed as the Ministry of Housing and Urban Affairs (MoHUA) in July-2017 is the state government level organisation that provides the policy guidelines to the state government as well as the financial assistance. Generally, the role of ministry is as the facilitator who propose a policy or program which is further implemented by the states through their municipal bodies. However, states have the authority to decide whether to act on the matters or to modify it according to their interests binding to the overall vision of the ministry. Thus, the state governments are the important actors in planning system even though the ministry is significant on providing the policy guidelines and the financial resources. At the local level, the local governments particularly municipal corporation for the larger cities, municipal councils for medium cities and Panchayats for the small cities, are the main organisation responsible for the local planning activities. But the degrees to which decision-making power have been decentralised varies from the state to state.

Class	Definition (Population)	Census 2001			Census 2011			Decade growth rate 2001-2011	
		no. of towns	Population	% of urban population	no. of towns	Population	% of urban population	no. of towns	Population
Class 1	>1 lakh	394	196.3	68.7	468	264.9	70.2	18.8	34.9
of which									
Below Mn+	1 to 10 lakh	359	88.0	30.8	415	104.2	27.6	15.6	18.4
Million plus cities	>10 lakh	35	108.3	37.9	53	160.7	42.6	51.4	48.4
of which									
Mega cities	>1 crore	3	42.5	14.9	3	48.8	12.9	0.0	14.8
Class II	50k to <100k	496	27.8	9.7	605	41.3	11.0	22.0	48.7
Class III	20k to <50k	1388	35.2	12.2	1905	58.2	15.4	37.2	65.5
Class IV	10k to <20k	1561	19.5	6.8	2233	31.9	8.5	43.0	63.8
Class V	5k to <10k	1041	6.7	2.4	2187	15.9	4.2	110.1	138.7
Class VI	<5k	234	0.7	0.2	498	2.0	0.5	112.8	180.1
Total		5161	286.1	100.0	7933	377.1	109.8	53.7	31.8
Statutory towns		3799	265.1	92.7	4041	318.5	84.5	6.4	20.2
Non-statutory towns & UAs		1362	21.0	7.3	3892	58.6	15.5	185.8	179.0
Total urban population		5161	286.1	100.0	7933	377.1	100	53.7	31.8

Tabel 1 - Census of India. (Source: URDPFI Guidelines, 2015 & Census of India)

Urban Planning and Development process

The overall urban planning and development involves cooperation between planning organisation, government as well as the people. After the independence, the top-down approach was being applied in the urban planning system in India in which the planning organisation prepare the development plan for the respective city which is approved by the state governments. Overall process of legalising the plan included the following steps:

- Preparation of the development plan (Generally 20 years)
- The draft is made available to the people for the objections and suggestions
- Finalising of the plan after the hearings from people
- Final development plan along with the proposed land use map for the approval by the state governments

After several years, the urban planning and Development process witnessed significant modifications and further bottom-up approach being applied as the preferable alternative which involves people in all the stages of the preparation of the plan. The 74th Constitutional Amendment Act in 1992 provided the base for multistakeholder participation in urban and regional planning.

For the balanced development of the regions, The Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines were prepared in the year of 1996. Over the period of time, the urban sector in India witnessed many changes in terms of rapid urbanisation, globalisation, advancement of technologies etc. this resulted in many new aspects to be considered in the urban and regional planning such as inclusive planning, sustainable habitat, integration of the land use and transport, disaster management as well as the networks of the communication, electricity, roads, water supply, sewage and solid waste. With considering all these aspects in planning of the urban and regional areas, Ministry updated and published the new updated version of the Urban and Regional Development Plans Formulations and Implementations (URDPFI) Guidelines in the year of 2015. In this, the participatory approach was taken into account in order to revised the guidelines to properly understand the proactively involved the Government of India Ministry and state governments for guiding the urbanisation. The URDPFI guidelines are intended to be comprehensive for promoting balanced and orderly regional and urban planning and development which provide the framework, necessary techniques, norms and standards, options for resource mobilization including land assembly approaches and land development regulations. (URDPFI, 2015) The guidelines are intended to be a reference for various aspects of planning by State Governments, Development Authorities, Private Sector and Planning Organizations and private entities. (URDPFI, 2015).

As per URDPFI guidelines, Urban and regional planning has been divided under two parts:

1) Core Area Planning
2) Specific and investment planning

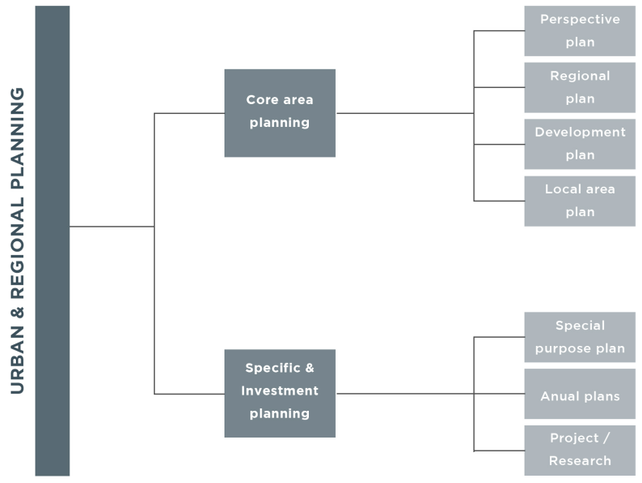


Fig 53. Division of urban planning in India. (Source: URDPFI Guidelines, 2015)

All the plans included in the planning process are directly or indirectly related to the land development raging from the different levels from national to urban areas. A Perspective Plan is generated at the State or Regional level which contains the development strategy. This is further detailed out in the Regional or Sub-regional Plan or in the Development Plan. Perspective Plan is guiding document for planning which also specify the regional planning authorities, urban/local planning authorities, regulatory authorities in the state as well as those who are responsible for preparing plan at various levels. Regionals plans are prepared at the district or metropolitan regional level.

For the balanced development of the regions, The Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines were prepared in the year of 1996. Over the period of time, the urban sector in India witnessed many changes in terms of rapid urbanisation, globalisation, advancement of technologies etc. this resulted in many new aspects to be considered in the urban and regional planning such as inclusive planning, sustainable habitat, integration of the land use and transport, disaster management as well as the networks of the communication, electricity, roads, water supply, sewage and solid waste. With considering all these aspects in planning of the urban and regional areas, Ministry updated and published the new updated version of the Urban and Regional Development Plans Formulations and Implementations (URDPFI) Guidelines in the year of 2015. In this, the participatory approach was taken into account in order to revised the guidelines to properly understand the proactively involved the Government of India Ministry and state governments for guiding the urbanisation. The URDPFI guidelines are intended to be comprehensive for promoting balanced and orderly regional and urban planning and development which provide the framework, necessary techniques, norms and standards, options for resource mobilization including land assembly approaches and land development regulations. (URDPFI, 2015) The guidelines are intended to be a reference for various aspects of planning by State Governments, Development Authorities, Private Sector and Planning Organizations and private entities. (URDPFI, 2015).

Different authorised governmental organisations and institutions are involved in the urban and regional planning in India. Different level organisations are as below:

1) National Level – Ministry of Housing and Urban Affairs (MoHUA) acts as a main authorised ministry. Other agencies include Ministry of Environment, Forest and Climate Change (MoEFCC) which is nodal agency for the administrative structure of the central government for the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programs, Niti Aayog (Public policy think tank of the Government of India), National disaster management Authority (NDMA) etc.
2) State Level – It includes Urban Development Department including Housing, Water and Sanitation, Environment, Finance, State Planning board, State Disaster management Agency, Metropolitan Planning Committees etc.
3) Local Level – It includes City Governments such as Municipal Corporation, Municipality Council, Nagar Panchayat etc.
Other institutions are also constituted for the planning and development of the city.

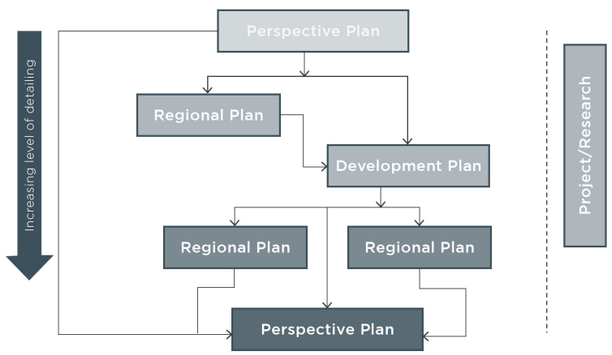


Fig 54. Plans included in planning process (Source: URDPFI Guidelines, 2015)

Some of the major Urban development program of the Government of India by Ministry of Housing and Urban Affairs (MoHUA) includes:

- Jawaharlal Nehru national Urban Renewal Mission (JNNURM)
- Urban Transportation – Bus rapid Transition System (BRTS)
- Swachh Bharat Mission (SBM)
- The Smart City Mission
- Atal Mission for Rejuvenation and Urban Transformation Project (AMRUT)
- Pradhan Mantri Awas Yojana for Housing for All by 2022 Mission

Plan	Approving authority
Perspective plan	State government
Regional plan	State government/Regional development authority
Development plan	Municipal corporation/Development Authority/MPC
Annual plan	Municipal council/Municipal corporation/Development authority
Zonal development plan	Municipal corporation/Development authority/MPC
Urban revitalisation plan	Municipal corporation/Development authority/MPC
City development plan	As above
Comprehensive mobility plan	As above
City sanitation plan	As above
Projects / Research	Municipal corporation/Development authority/MPC

Table 2 - Approving authorities of the specific plans (Source: URDPFI Guidelines, 2015)

4.2.

Climate change in India | Climate planning in India

Climate change is the most critical and largest global issue and a threat to natural environment and urban societies. Many related events have significantly revealed the vulnerabilities of the urban areas to the climate change and it varies from effects on agriculture, food security, sea level rise, increasing natural disasters etc. Urban centres are not only the generators of the greenhouse gas (GHG) emissions, which are the main causes of the climate change, but, in turn, are also affected by the impacts of climate change (Source: Environment & Urbanization - International Institute for Environment and Development (IIED))

The vulnerability assessment and adaptation studies of the climate change were made in various areas including water resources, agriculture, forests, natural eco-systems, coastal zones, health, energy and infrastructure being part of the preliminary national Communication of India to the United Nations Framework Convention on Climate Change (UNFCCC). However, the Ministry of Environment and forest created an expert committee on the impact of climate change in June-2007 to assess the impact of climate change in the six areas consisting water resources, agriculture, natural eco-systems, health, coastal zone management and climate modelling. Further, they developed a range of policies and programs to address the problem of climate change in terms of sustainable development.

National Action Plan on Climate Change (NAPCC)

The National Action Plan on Climate Change (NAPCC) was published by the Prime Minister of India on 30th June, 2008. It outlines an overall national strategy whose aim is to enable he country to adapt the climate change and enhance the ecological sustainability of country's development path. It emphasizes on the maintenance of the high growth rate is essential for increasing living standards of the vast majority of people of India and reducing their vulnerability to the impacts of climate change. The National Action Plan is centred around eight 'National Missions'. They mainly focus on the promotion of the knowledge and understanding of climate change, adaptation and mitigation, energy efficiency and natural resource conservation.

The eight National Missions on climate change are as follow:

1) National Solar Mission
2) National Mission for Enhanced Energy Efficiency
3) National Mission on Sustainable habitat
4) National Water Mission
5) National Mission for Sustaining the Himalayan Eco-system
6) National Mission for a Green India
7) National Mission for Sustainable Agriculture
8) National Mission on Strategic Knowledge for Climate Change

The main principles of the National Action Plan for Climate Change (NAPCC) are as follow:

- Protecting the poor with a climate change-aware, inclusive, and sustainable development approach
- Reaching the national growth and targets of poverty reduction while maintaining ecological sustainability
- Efficient and cost-effective strategies for end-use demand-side management
- Extensive and accelerated deployment of appropriate technologies for adaptation and mitigation
- New and innovative market, regulatory, and voluntary mechanisms for sustainable development
- Effective implementation through unique linkages with civil society, LGUs, and public-private partnerships

The National Action Plan for Climate Change (NAPCC) has stimulate certain entry points and several international agencies including World, Bank, the International Council for Local Environmental Initiatives, the World Wide Fund for nature (WWF), the Asian Cities Climate Change Research network (ACCCRN) and the Urban Climate Change Research Network (UCCRN) have started pilot projects in Indian cities.

Table 1 - A summary of initiatives on climate change. (Source: Sharma, D., & Tomar, S. (2010). Mainstreaming Climate Change Adaptation in Indian Cities – sage journals.)

Study/Project/Policy/ Intervention	Supported/Initiated by	Year
Climate change mitigation and impact assessment		
Asian Least-cost Greenhouse Abetment Strategy (ALCGAS)	Supported by the Global Environment Facility (GEF) & implemented by ADB	1998
India's initial communication to the UNFCCC through National Communication Project (NATCOM)	Supported by UNDP/GEEF & coordinated by the Government of India's Ministry of Environment and Forests	
Climate Impact Assessment study	Supported by DEFRA (UK Government)	
Disaster risk reduction and management strategies		
Gujarat State Disaster Management Authority (GSDMA)	Government of Gujarat	2001
Integrated Coastal Zone Management Plans (ICZMPs) and a review of the principles and norms for managing Coastal Regulation Zones (CRZs)		2005
Strategies having adaptation as one or main component		
India's National Action Plan for Climate Change (NAPCC)	Introduced by the Prime Minister's Office of the Government of India	2008
National Mission on Sustainable habitat (NMSH)	Prepared by the Government of India's Ministry of Urban Development	2009
ICLEI and WWF		
Asian Cities Climate Change Research Network (ACCCRN)	Supported by Rockfeller Foundation	
Urban Cliamte Change Research Network (UCCRN)		

CHAPTER

05

ADAPTATION STRATEGIES FOR SURAT (INDIA)

5.1.

From theory to practice |
Presentation of the study area (Overview)

The Surat city, located in the western part of India in the state of Gujarat, is one of the most vibrant cities in India, with the highest rate of growth due to immigration from all over the country stating around 55.58% of population as migrants. Considered as one of the cleanest cities of India, Surat is also known by several other names such as “The diamond city” and “The green city”. In terms of population, it is the second biggest city in Gujarat. It has a thriving economy as a diamond and textile manufacturing center. The city has served as a significant trading hub due to its location and today also it has been constantly evolving, consequently, facing the effects of urbanization as well as global issues of climate change. The city is comprising of two main administrative bodies - Surat Municipal Corporation and Surat Urban Development Authority.[1]

8th largest city in India

4th fastest growing city in the world

Economic capital of Gujarat with diamond and textile industry

Surat is located at 210 12’ N and 720 50’ E and has an elevation of 13 meters above mean sea level. It is situated on the bank of River Tapi with having the coastline of Arabian Ocean of around 35 meters on the west. It is well connected from Delhi to Mumbai through national highway no. 8. The city of Surat has been ranked second in Smart City Mission of India and as the cleanest city of the India.

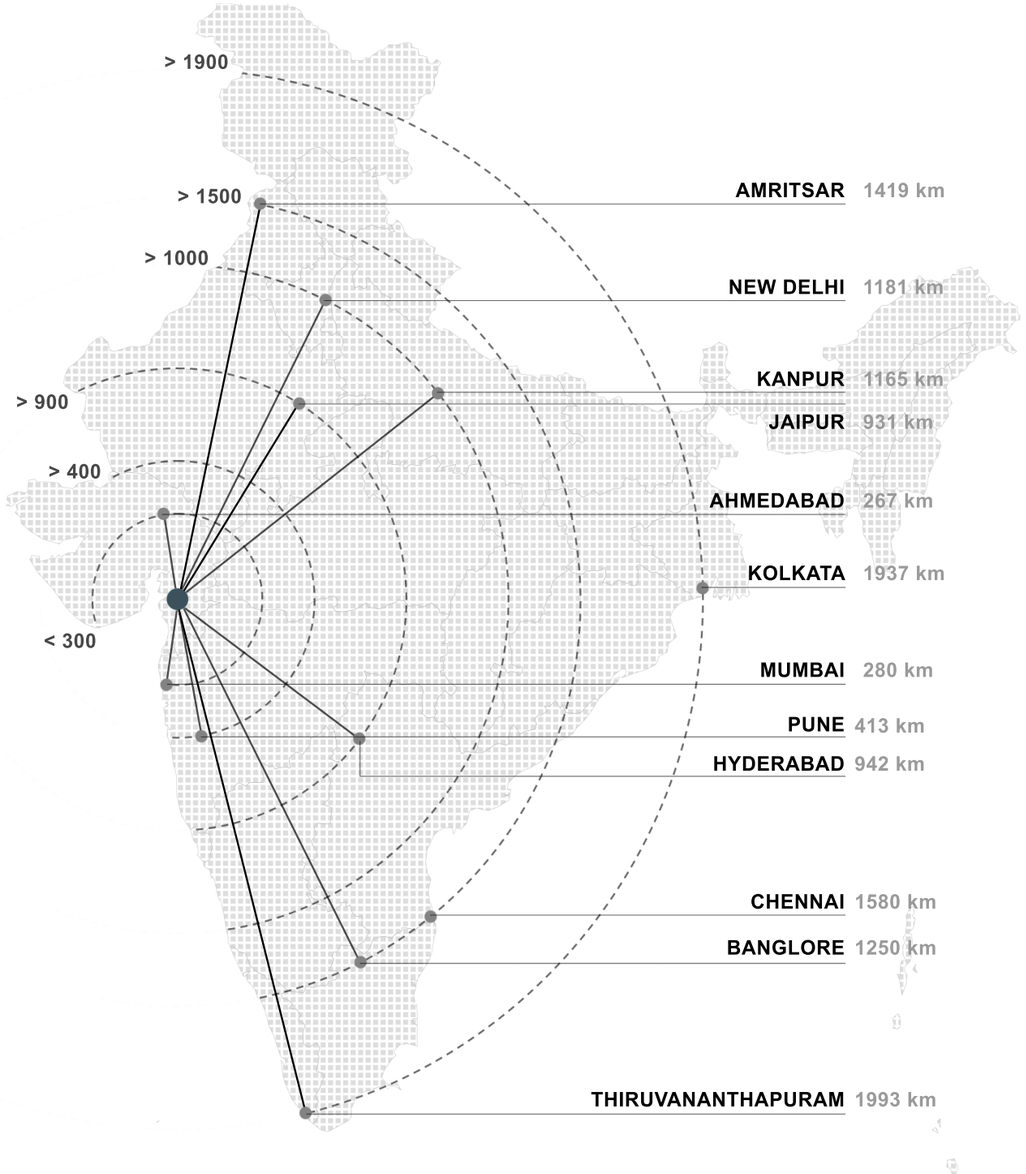


Fig 55. The map of India showing location of Surat along with its distance from other main cities of India.
Author’s elaboration

Demographics

Oldest Municipality - 1852 AD

Population - 4,645,384 (As per Census-2011)

Desnsity - 10052 persons/sq.km. (As per Census-2011)

Decadal growth - 55.29% (As per Census-2011)

Current population (2023) - 8,065,000 (Approax)

Number of zones - 9 (Figure-1)

Climate characteristics

The city of Surat is distinguished by its tropical Savanna climate, which incoporates various characteristics. Summers are often hot and dry from March to June, with temperatures ranging from 37^{0} C to 44^{0} C. The monsoon season begins in June and lasts until the month of September, which is a pleasant climate accounting for an annual rainfall of 1143 mm. The season of monsoon is quite important for the city since it provides the signifacant amount of water sources, replenishing the level of River Tapi. Winters are rather moderate, with an average temperature of 15^{0} C. Being located on the coastal area, the city of Surat s especially vulnerable to cyclonic storms during the monsoon seasons, resulting in extreme weather events and flooding issues. Further, this contributes to higher levels of humidity, often higher as 70%.

Administrative zones of Surat

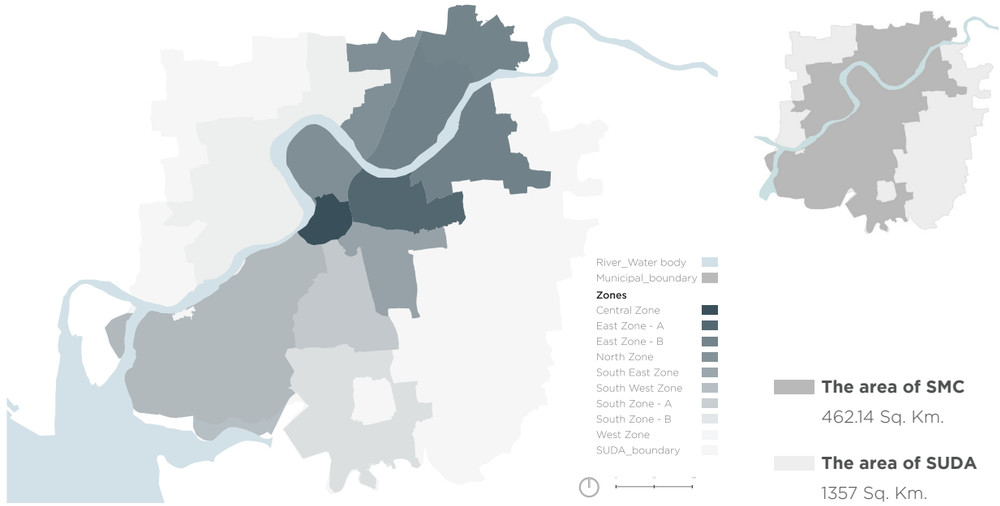


Fig 56. The map of administrative zones of Surat.
Author's elaboration

Average temperature of Surat

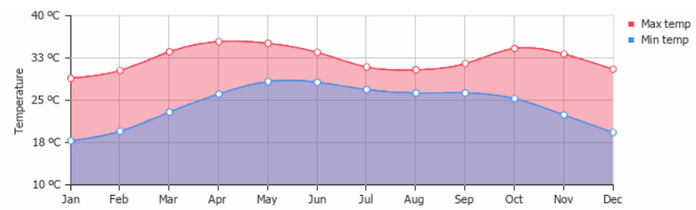


Fig 57. Average temperature of Surat.
Weather and Climate information for any destination in the world. World Weather & Climate Information. Retrieved December 1, 2023, from https://weather-and-climate.com

Average monthly precipitation

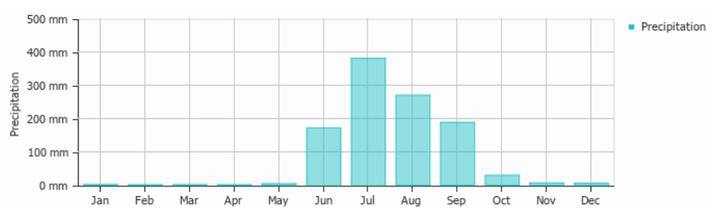


Fig 58. Average precipitation of Surat.
Weather and Climate information for any destination in the world. World Weather & Climate Information. Retrieved December 1, 2023, from https://weather-and-climate.com

Population density of Surat - 2001

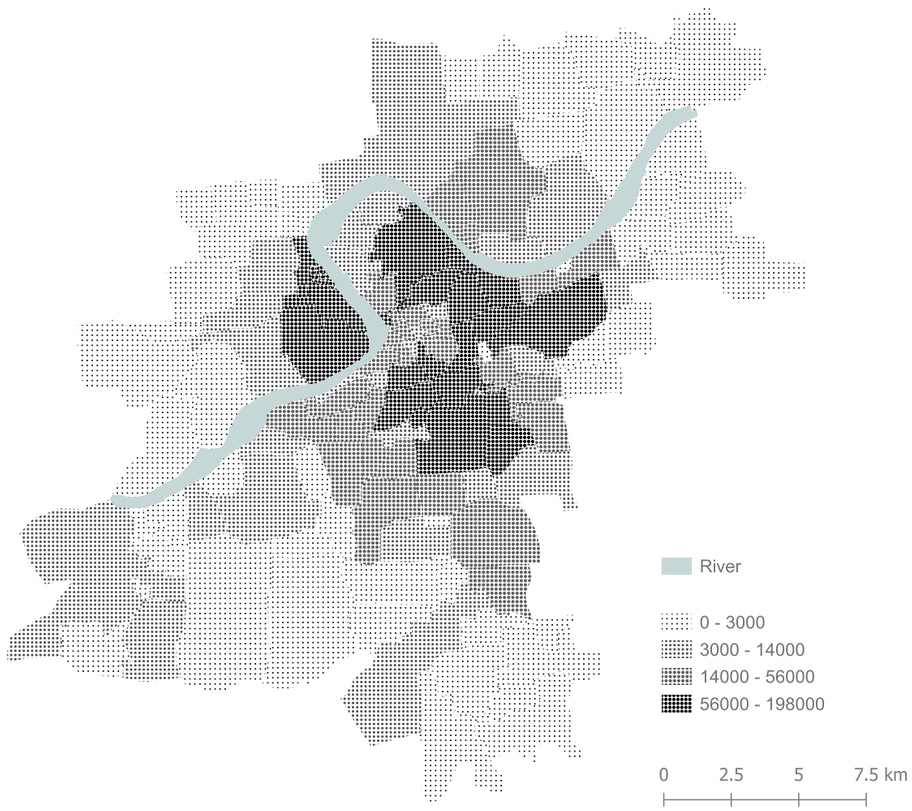
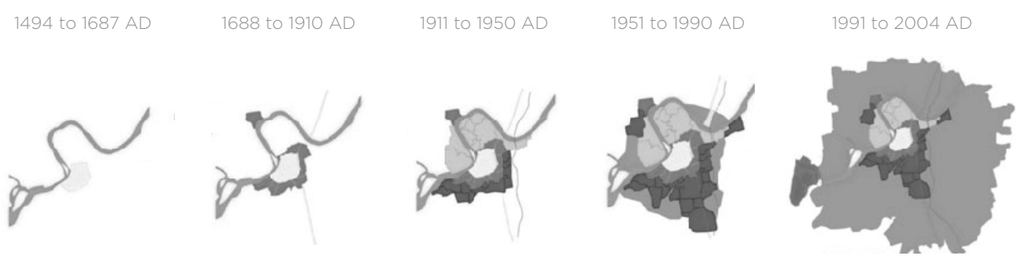


Fig 59. Map of population density of Surat in the year of 2001.
Author's elaboration



Population density of Surat - 2011

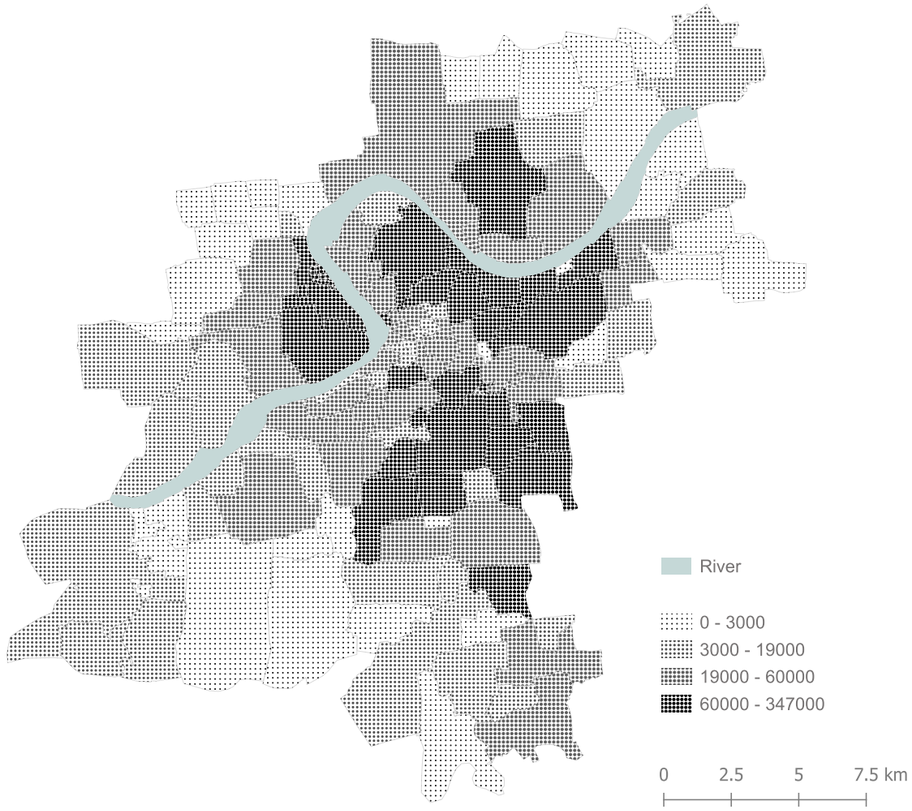


Fig 61. Map of population density of Surat in the year of 2011.
Author's elaboration

Fig 60 (Previous page). Evolution of Surat.
Patel, D., & Srivastava, P. K. (2014, January 1). Application of Geo-Spatial Technique for Flood Inundation Mapping of Low Lying Areas. Society of Earth Scientists Series. https://doi.org/10.1007/978-3-319-05906-8_7

5.2.

From theory to practice | Current scenario

Critical urban problems exacerbating effects of climate change in Surat

- Urbanization
- Innovations and Infrastructures
- Migration

Major climate change effects in the city of Surat

- Sea-level rise
- Higher temperatures
- Flooding (Coastal and Inland)
- Cyclones and severe storms

Significant organisartions paving the pathway of climate change adaptation in the city

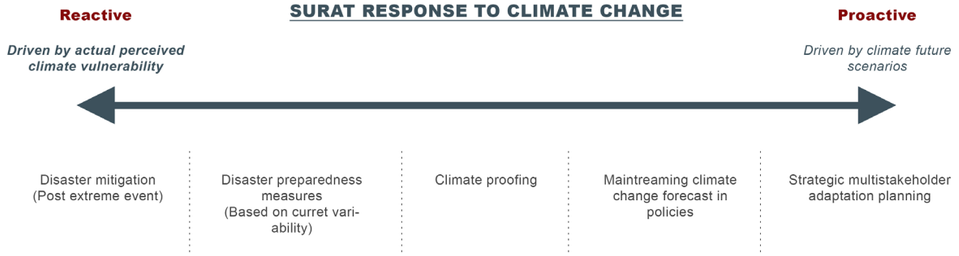
- Surat Municipal Corporation (SMC) [City level]
- Surat Climate Change Trust (SCCT) [City level]
- Gujarat State Disaster Risk Management Authority (GSDMA) [State level]
- The Ministry of Environment, Forest and Climate Change (MoEFCC) [National level]
- Asian Cities Climate Change Resilience Network (ACCCRN) [International level]

Climate change policies in Surat

- Surat Climate Resilience Strategy
- City Heat Resilience Toolkit for Surat
- Surat Clean Air Action Plan

Other projects and programs

- Urbanshift Program
- Urban Health & Climate Resilience Center of Excellence




Resilient cities
Cities

Indian city of Surat anticipates worst effects of climate change

Gujarat city on India's west coast is preparing to cope with twin disasters brought on by rapid growth and global warming

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About this content

Julien Bouissou

Mon 15 Sep 2014 11.00 CEST

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Flooding in Surat, India, in 2006. Photograph: Strdel/Getty

Fig 62. The news article in 'The Guardian'. News, sport and opinion from the Guardian's Europe edition | The Guardian. Retrieved December 1, 2023, from https://www.theguardian.com/

Fig 63. Map showing built area of Surat. - Author's elaboration

Fig 64. Map showing road network of Surat. - Author's elaboration

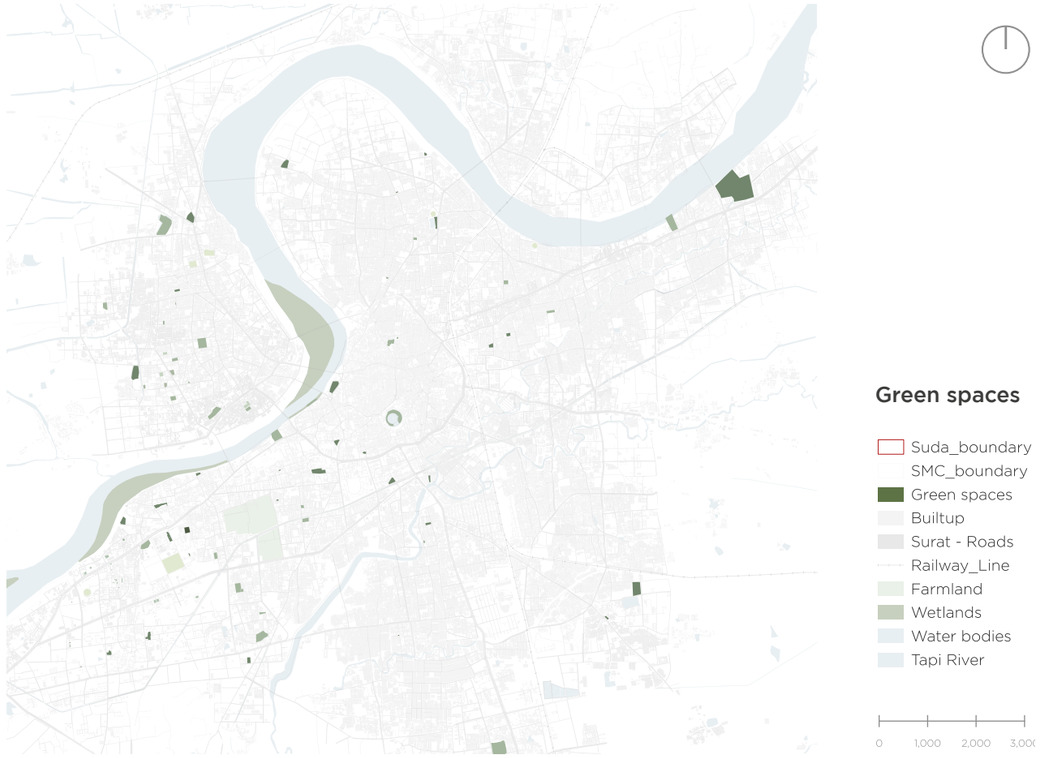


Fig 65. Map showing existing green spaces of Surat. - Author's elaboration

Fig 66. Map showing NDVI Index to highlight the green cover of Surat city. Generated with the help of EO-Browser (Sentinel-hub EO-Browser3. Retrieved December 1, 2023, from https://apps.sentinel-hub.com/eo-browser/)

Public spaces in the city of Surat are very less compare to the degree of urbanization and growing population. However, NDVI index map shows that city comprises the green areas due to existing farmlands and tree cover.

Existing per capita green space - 2.7 Sq.m.

Required - 10 Sq.m.

5.3.

From theory to practice | Statement of the problem

Land Surface Temperature of Surat

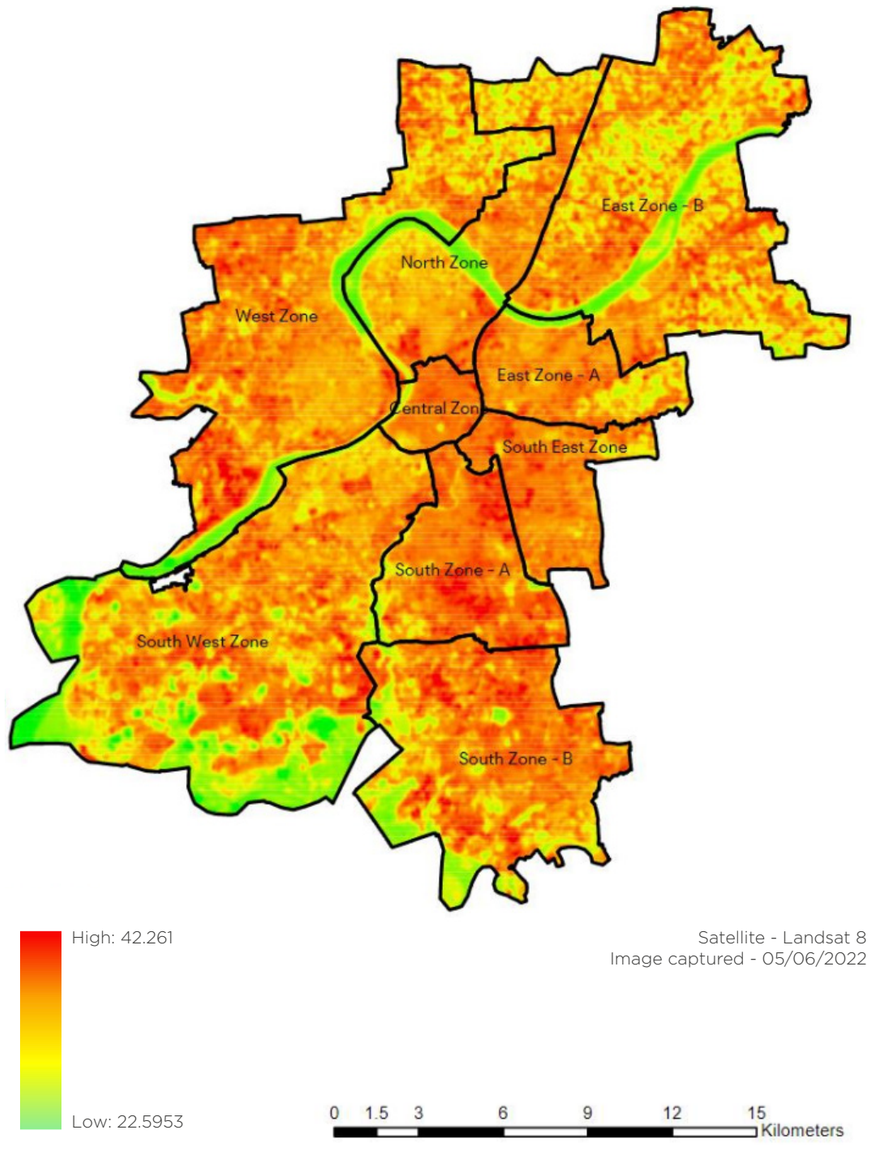


Fig 67. Map showing Land Surface Temperature (LST) of Surat.
Source: Land Surface Temperature Maps-Surat and Rajshahi. (2022).

Flooding depth of Surat

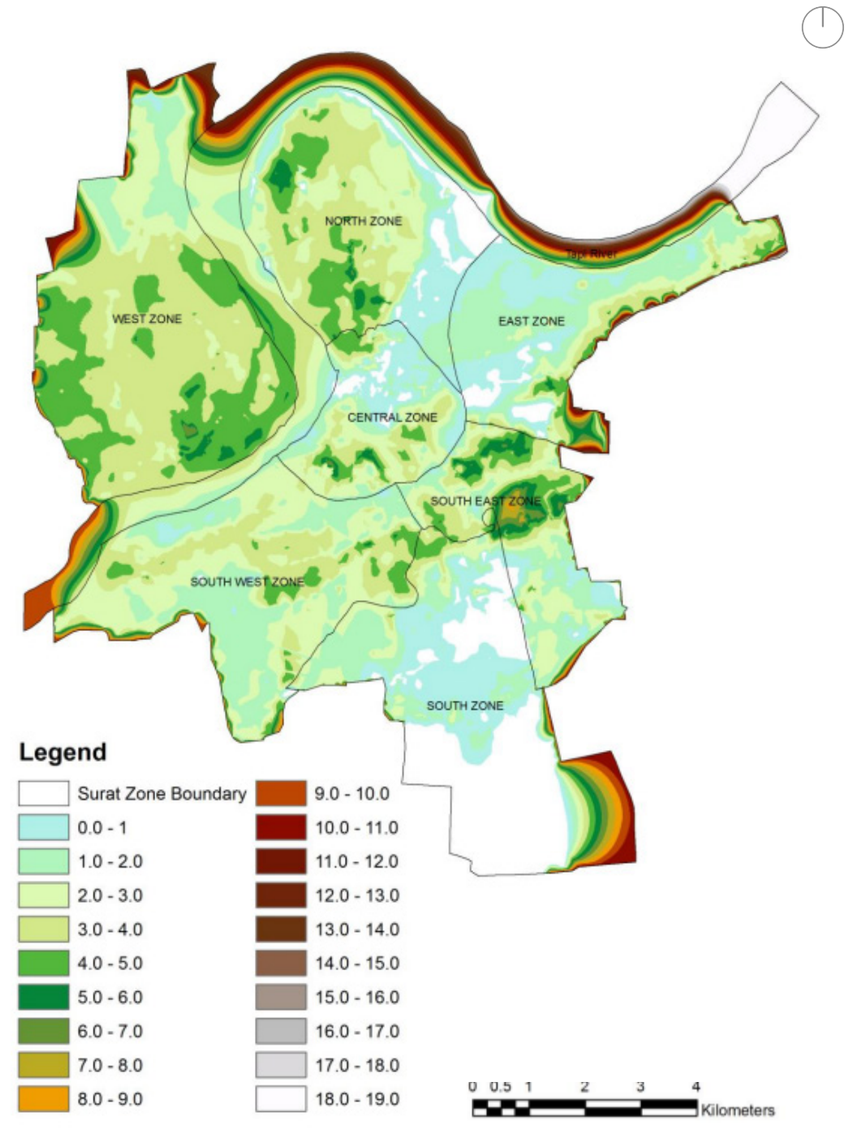


Fig 68. Map showing depth of flooding in Surat (2006).
Source: (Patel et al., 2017)

Vulnerable urban areas due to increasing Land surface temperateure

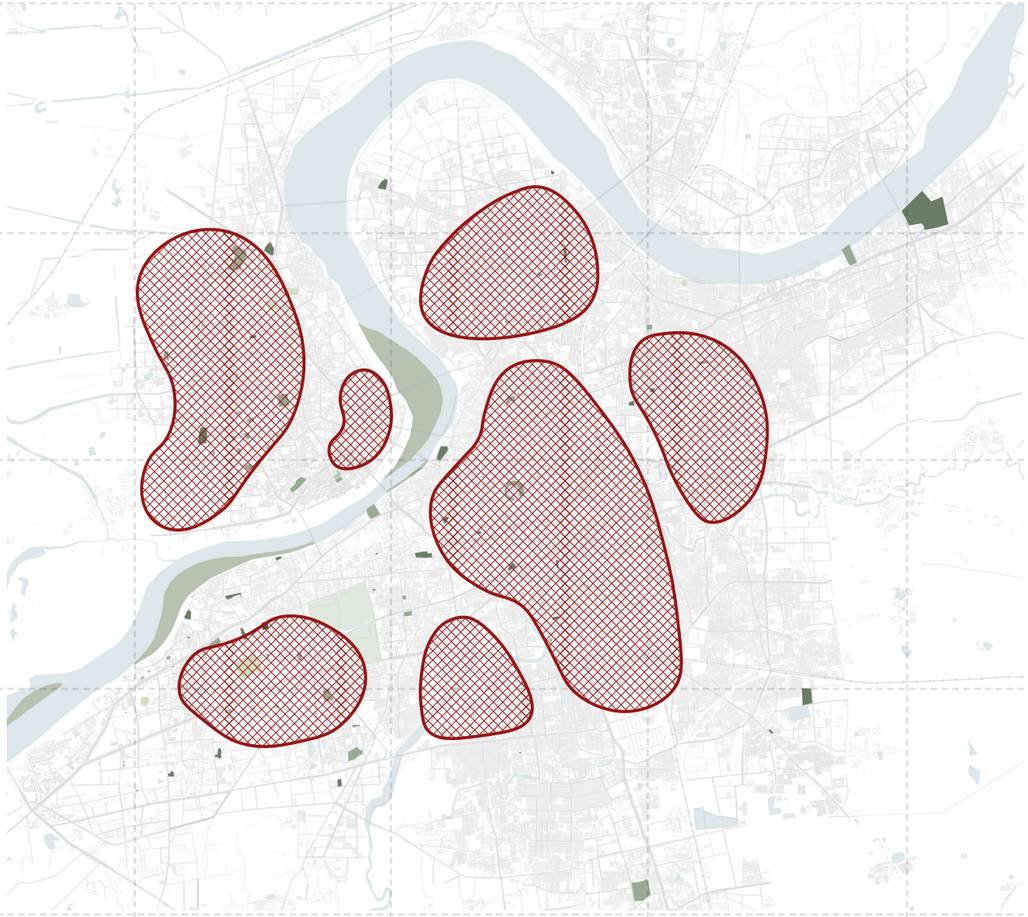


Fig 69. Map showing vulnerable urban areas of Surat due to urban heat island effect.
Author's elaboration

The map shows the vulnerable urban areas due to increasing land surface temperature resulting in the issues of urban heat island effects. Mainly, the areas with dense urban fabric, industrial zones, vehicular traffic are located in this zones.

Vulnerable urban areas due to flooding

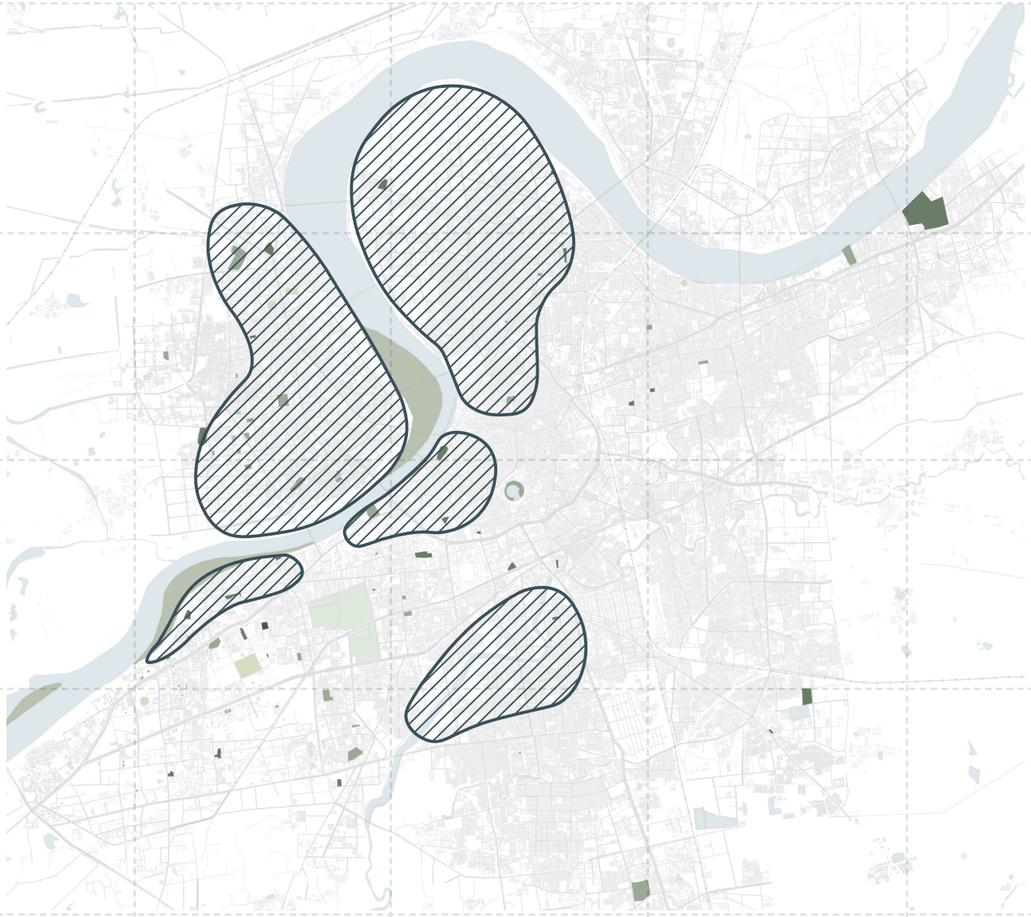


Fig 70. Map showing vulnerable urban areas of Surat due to flooding issues.
Author's elaboration

The map shows the vulnerable areas due to fluvial and pluvial floodings during heavy rainfall. Mainly, the these areas are near to the river and creek, which are low lying areas with higher risk.

Vulnerable urban areas due to dense urban fabric

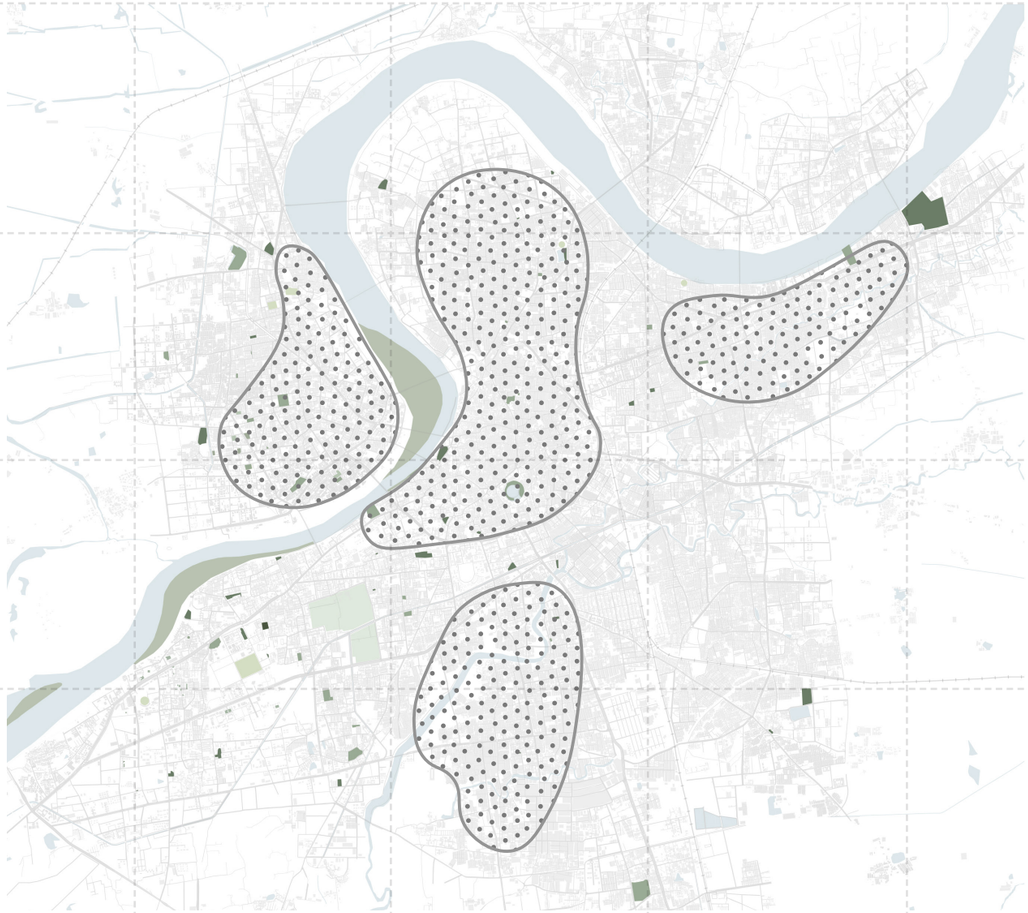


Fig 71. Map showing vulnerable urban areas of Surat due to dense built fabric.
Author's elaboration

The map shows the vulnerbale areas due to dense urban fabric. Mainly, these areas are consist of informal dwellings, old city area with very dense urban fabric as well as other areas with small scale industries.

Vulnerable urban areas with the need of more green public spaces

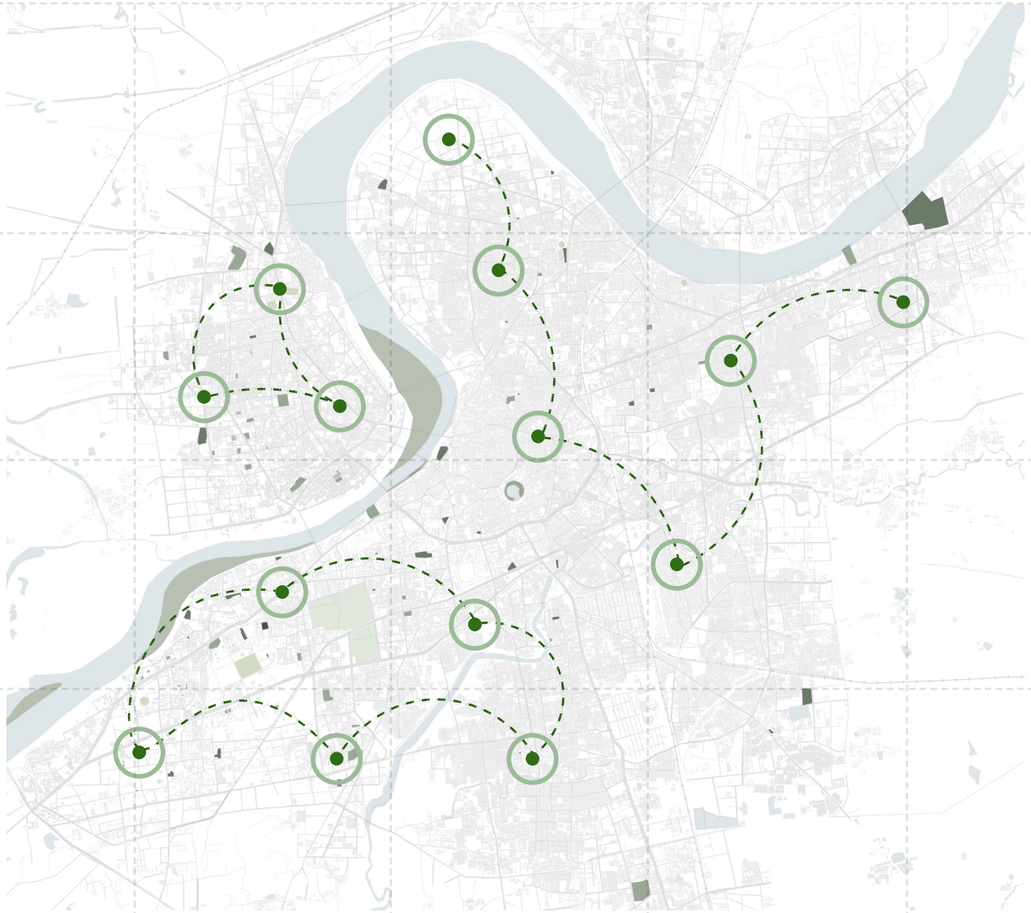


Fig 72. Map showing vulnerable urban areas of Surat that requires new green spaces.
Author's elaboration

The map shows the areas that fall under vulnarable zones of the city which are affected by multiple effects of climate change, which requres more green public spaces in order to adapt to this issues.

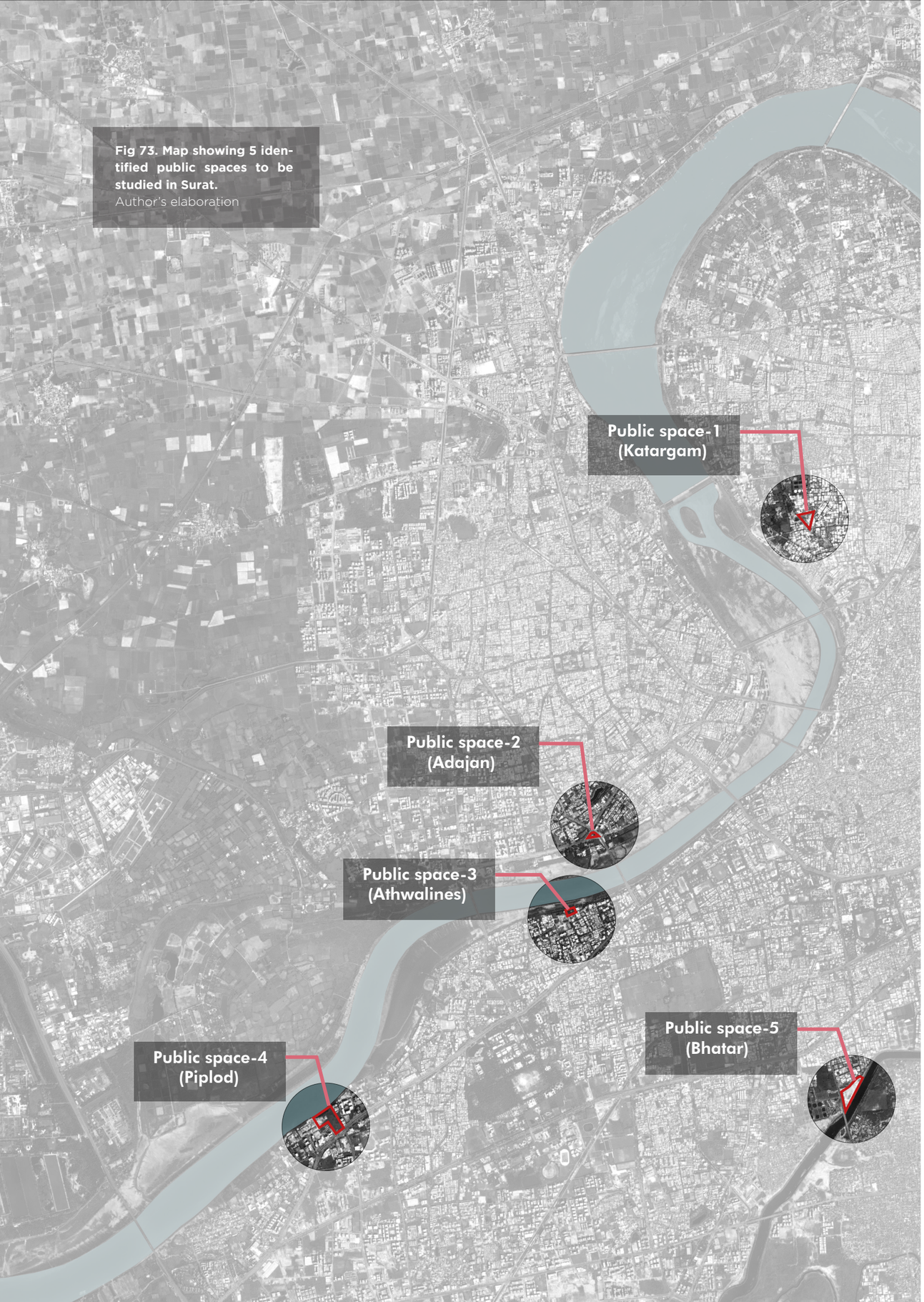


Fig 73. Map showing 5 identified public spaces to be studied in Surat.
Author's elaboration

5.4. From theory to practice | The main objectives and focus

MAIN OBJECTIVES

1 ***Identify***
Identifying the public spaces in vulerable zones of the city which can be activate and adapt to the effects of climate change

2 ***Assess***
Assessing the public spaces and context to understand how vulnerable they are to the present effects of climate change

3 ***Associate Needs***
Understanding the needs of urban areas based on their vulnerbaility assessment

4 ***Adapt***
Implementing various strategies to adapt the public spaces to the effect of climate change

5.5.

From theory to practice | Framework & Methodology

Indeed, the redesigning public spaces for climate change requires a meticulous framework while moving from theories to actual implementation. As a starting point, the climatic issues present in city of Surat were identified, such as flooding, rising temperatures, as well as extreme weather events. The overlaying of these data assist in identifying the most vulnerable urban areas affected by different factors, which helps in identifying the public spaces that are located in critical urban areas affected by multiple climatic effects and urban challenges. Moreover, it is crucial to identify various stakeholders and engage them in the process as a part of co-designing.

Secondly, it is necessary to understand the context of the identified public spaces along with problems of the specific spaces, such as presence of water body, river, green spaces, various zones of urban areas etc. For this, the urban elements needs to be identified that are highly exposed to the various effects of climate change. By analyzing various patters and identifying the sensitivity of these elements, the vulnerbaility of the public space can be assessed. Moreover, it is also necessary to analyze capacity of existing elements to understand their exposure towards various effects of cliamte change. In this way, it is possibe to gather data and knowledge of specific public spaces and their context along with the effects of cliamte change they are exposed to, which can help in further recognizing the strategies to adapt those spaces to the effects of climate change and implement them succesfully.

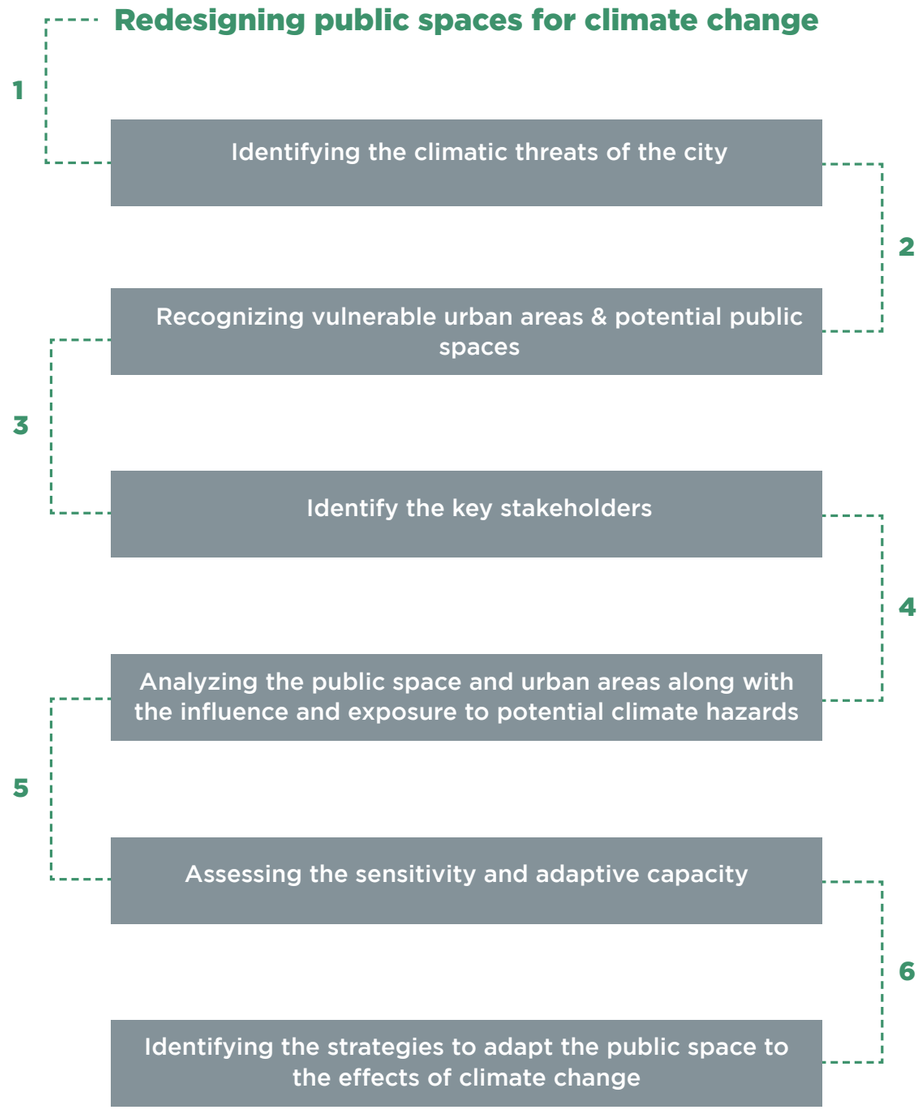


Fig 74. Methodology and framework.
Author's elaboration

5.6.

From theory to practice | Analyzing the public spaces

To analyse the five identified public spaces, multifaceted method was carried out to understand the vulnerability of the public spaces to the effects of climate change and understand the needs to adapt them faster towards climate change.

Firstly, the contextual analysis was carried out for all public spaces to identify various urban elements that are present in the proximity of the site. This was important to understand which urban elements are major factor in the context of public spaces and how they are functioning in the current scenario. Moreover, the climate change effects that are present in the specific urban areas of each public spaces were analyzed to know what are the challeneges that exist in the urban area that can have an impact on each public spaces. Also, availability of exsitng public spaces in the proximity of the site was analyzed to understand the need of the site.

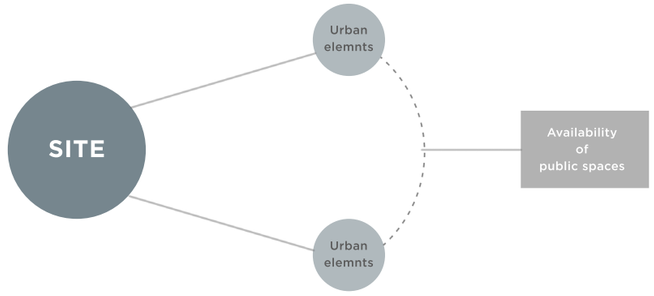


Fig 75. Identifying the urban elements and public spaces in the proximity of site.
Author's elaboration

Secondly, the observation about the each site specific issues were carry out to understand the current scenario of each public spaces and how they are functioning in their urabn areas. This was necessary to understand the sensiticty of this public spaces and their capacity to deal with the current effects of cliamte change they are expsed to.

Further, the relationship vetween each urban elements in the context of the site were understood in order to identify interconnection between them and how they are influencing each other, exacerbating their vulnerability. Additionally, the climatic hazard that each of this urban elements are exposed to were identified to better understand their complex dynamics.

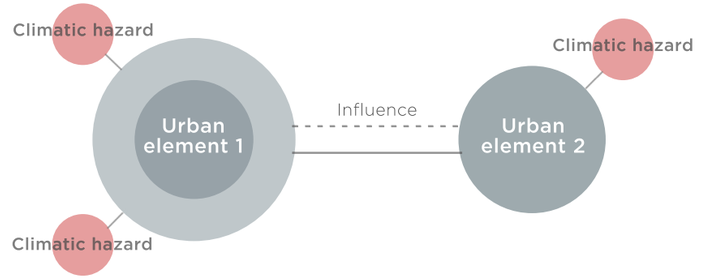


Fig 76. Influence and potential impacts.
Author's elaboration

Finally, the vulnerability assessment was carried out through ranking system to assess the vulnerability of urban elements to different climatic hazard. The ranking was given between 1 to 5, in which, 1 and 2 ranking indicates low vulnerability, 3 indicating medium vulnerability, while more than 3 represnts higher vulnerability to the effects of climate change. Assessing all the ueban elements against each climatic hazards helped in understanding the vulnerability of the overall urban areas and to gain better knowledge about the need of public space while redeigning them and recognising adaptation strategies to be implemented to activate them to deal with various effects of cliamte change.

	Low		Medium	High	
Vulnerability	1	2	3	4	5

Public Space - 1 | Katargam

Fig 77. Map showing location of Public space - 1 (Katargam).
Author's elaboration

Key map

Area - 13,302 Sq. m.

The site is located in the Katargam area in city of Surat with having large areas covered by the various scales of industries. The residential area near to the site has very dense fabric, also comprising the informal dwellings due to presence of industries. Industrial area is a major contributor in the air pollution, while also exacerbating the land surface temperature of the neighbourhood along with the densly built urban fabric. Moreover, Site is located very near to the River Tapi, causing a higher risk of flooding in the area during the heavy rainfalls. The industrial waste is disposed on the site leading the to problem of soil pollution.

Fig 78. The whole site is currently being used as a dumping area for all types of waste, whichs is polluting the soil and making it less suitable to grow plants and trees

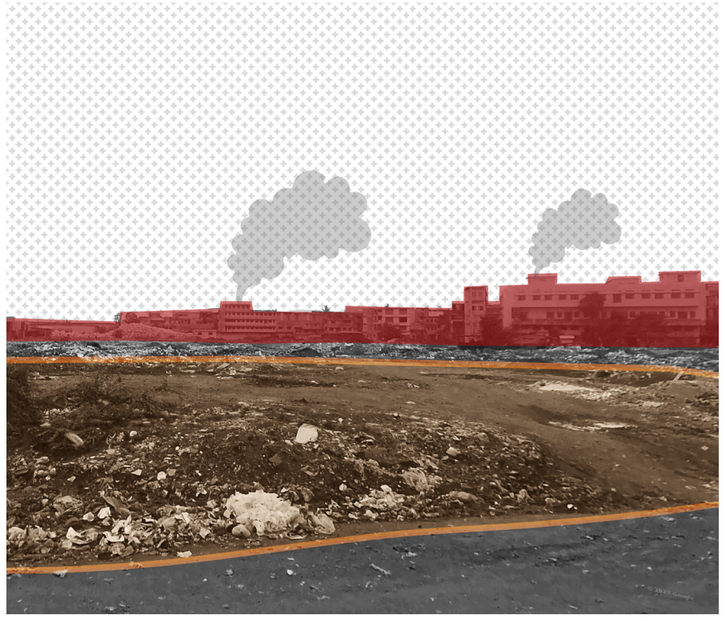
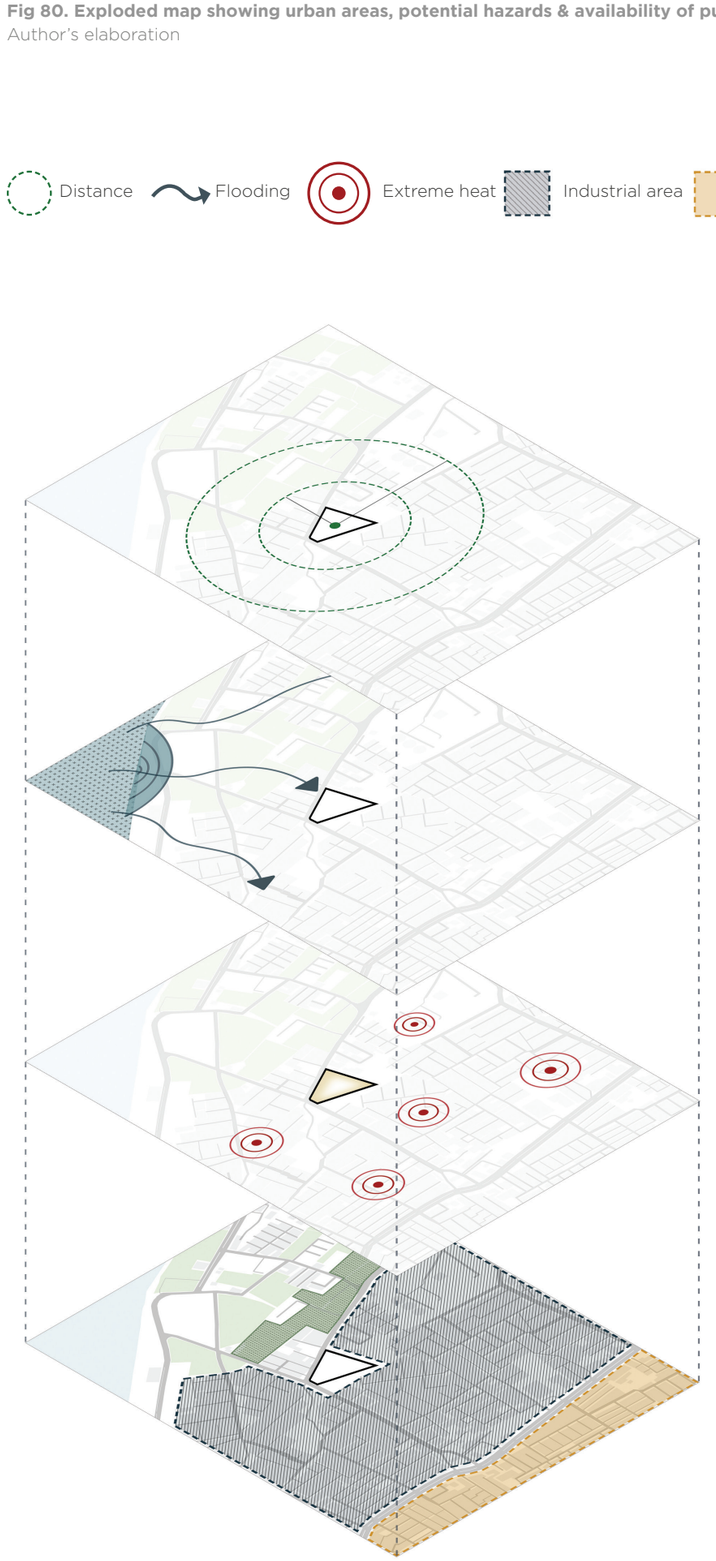


Fig 79. The site is surrounded by various scales of indutries, which pollutes the air due to gas emissions & significantly contribute in increasing L.S.T.

Fig 80. Exploded map showing urban areas, potential hazards & availability of public space - 1 (Katargam).
Author's elaboration



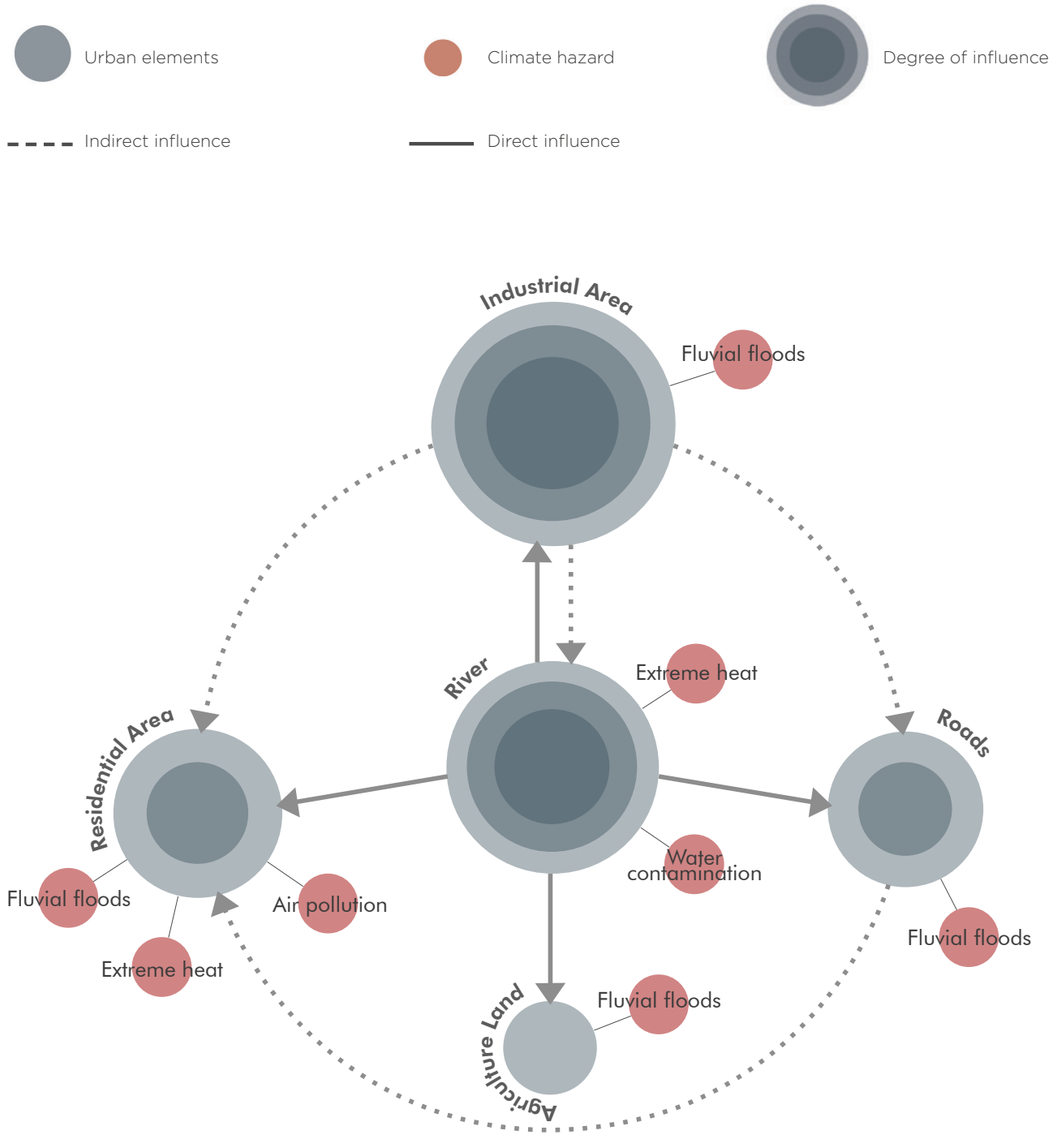


Fig 81. Relationship between various urban element along with their influences and potential climate hazard for public space - 1 (Katargam).
Author's elaboration

The figure represents the connection between various urban elements that exist in the context of the site, including how they all have influences on each other in terms of causing various negative effects in direct or indirect way. The site has mainly Industrial area as a dominant factor, while accompanying with dense residential area, river, small portion of agriculture land as well as the roads.

Public Space - 2 | Adajan

Fig 82. Map showing location of Public space - 2 (Adajan).
Author's elaboration

Key map

Area - 4238 Sq. m.

The site is located in Adajan area of Surat city. The presence of commercial zone along with mixed-use and residential zones attracts large amount of vehicular traffice. The site is situated at the junction of one of the primary roads as well as at the end of the bridge which connects two part of the city, making the site very crucial point. The primary roads and the bridge have heavy traffic during the peak hours which can cause increased vehicular emission in the air. Moreover, the site is also in the proximity to the river Tapi, thus, it is highly exposed to the risk of flooding during the season of heavy rainfall.

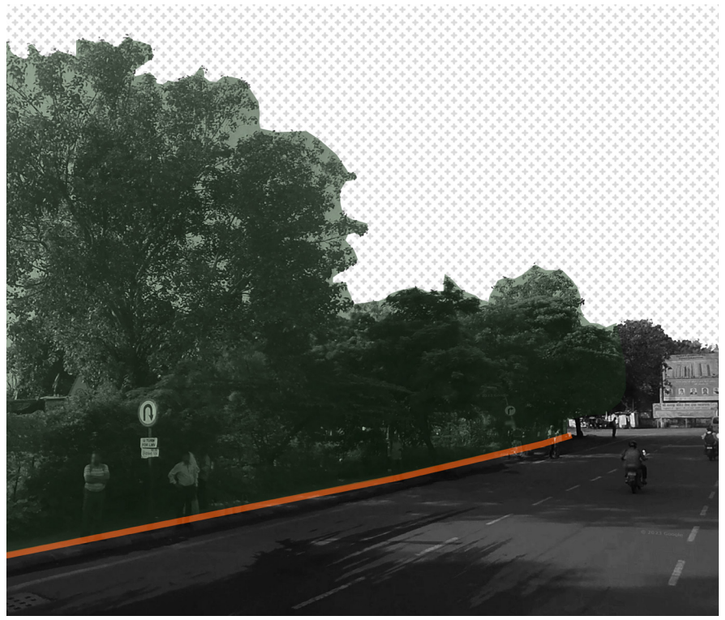
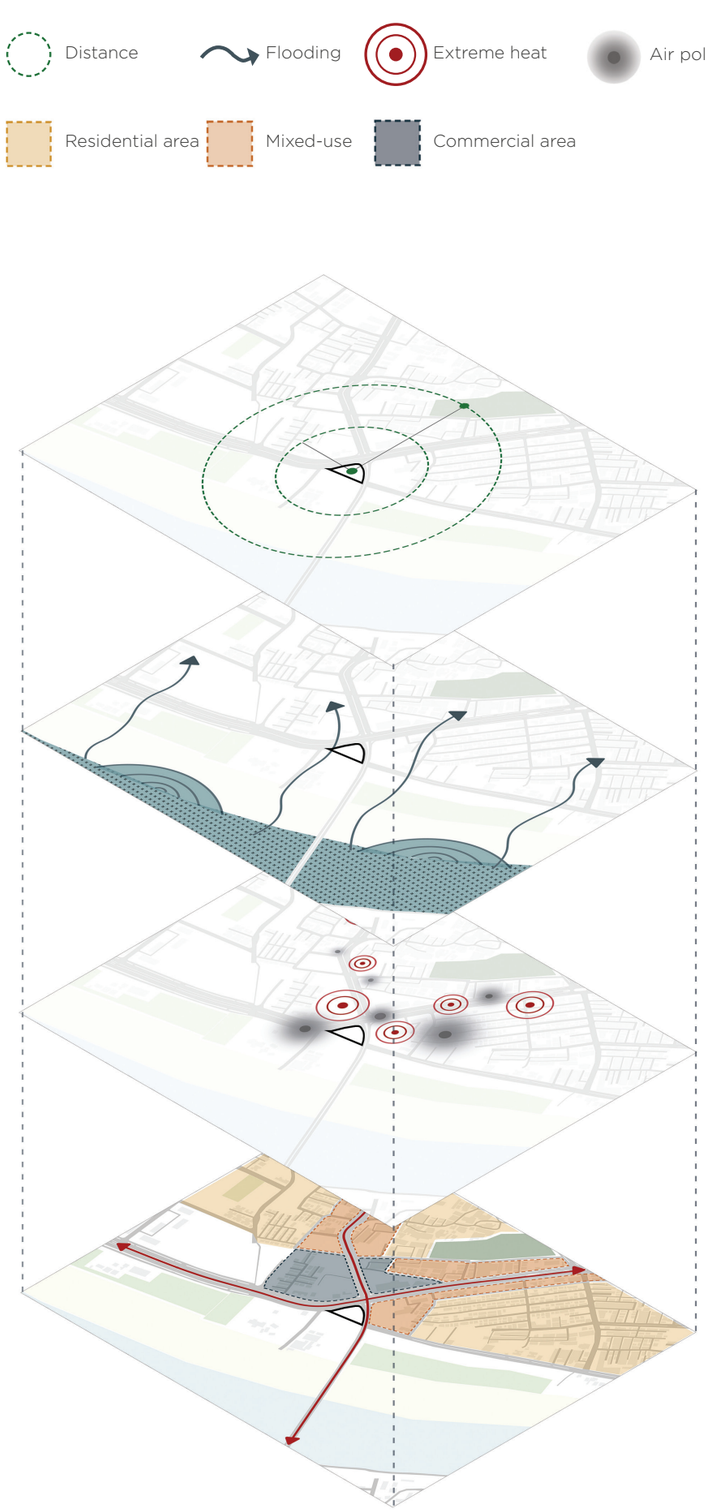


Fig 83. The whole site is currently being used as a dumping area for all types of waste, which is polluting the soil and making it less suitable to grow plants and trees

Fig 84. The site is surrounded by various scales of indutries, which pollutes the air due to gas emissions & significantly contribute in increasing L.S.T.

Fig 85. Exploded map showing urban areas, potential hazards & availability of public space - 2 (Adajan).
Author's elaboration



One public space available in the proximity of 400 meters

Proximity to the river increasing the risk of flooding

Increased land surface temperature and air pollution due to heavy vehicular traffic

Area comprising of commercial, residential, mixed-use zones as well as primary roads and bridge

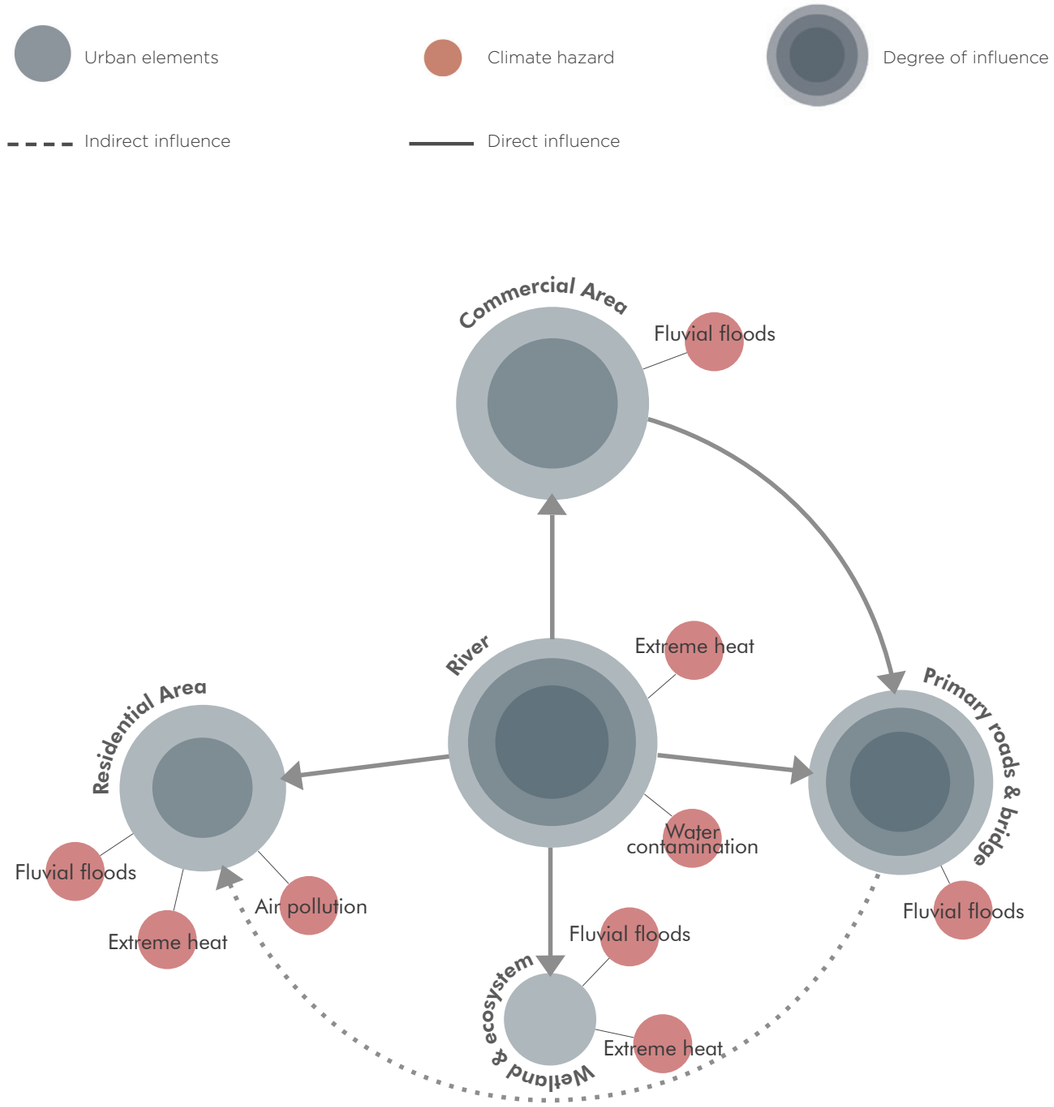


Fig 86. Relationship between various urban element along with their influences and potential climate hazard for public space - 2 (Adajan).
Author's elaboration

The figure above explains the relationship between various urban elements in context of the present site and in which way they influence each other, making them exposed to multiple climate hazard. The urban elements that act as a major factor in the proximity of site are mainly commercial areas, residential area, primary roads and bridge, the wetlands at the riverbank, and river Tapi being the dominant factor.

Public Space - 3 | Athwalines

Fig 87. Map showing location of Public space - 3 (Athwalines).
Author's elaboration

Key map

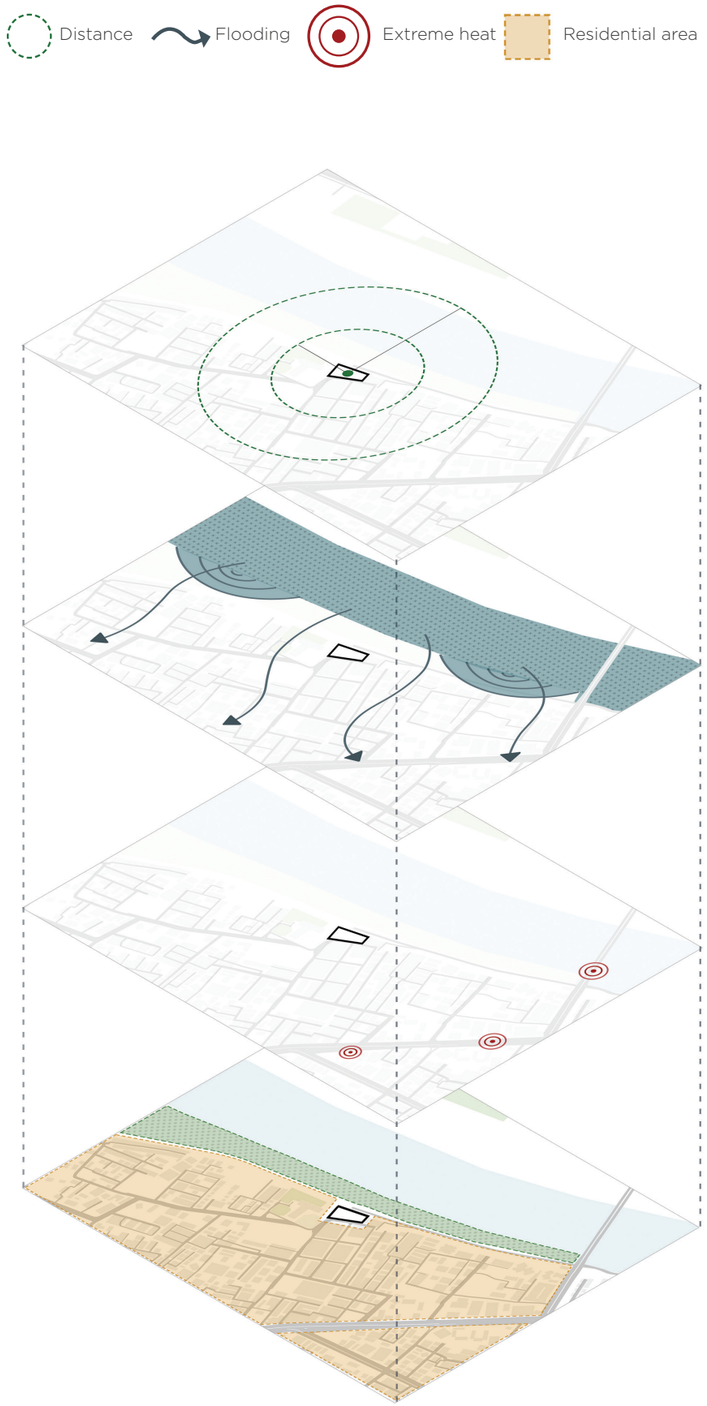
Area - 4113 Sq. m.

The Surat city, located in the western part of India in the state of Gujarat, is one of the most vibrant cities in India, with the highest rate of growth due to immigration from all over the country stating around 55.58% of population as migrants. Considered as one of the cleanest cities of India, Surat is also known by several other names such as "The diamond city" and "The green city". In terms of population, it is the second biggest city in Gujarat. It has a thriving economy as a diamond and textile manufacturing centre. The city has served as a significant trading hub due to its locatquentlyity.

Fig 88. The whole site is currently being used as a dumping area for all types of waste, which is polluting the soil and making it less suitable to grow plants and trees

Fig 89. The site is surrounded by various scales of indutries, which pollutes the air due to gas emissions & significantly contribute in increasing L.S.T.

Fig 90. Exploded map showing urban areas, potential hazards & availability of public space - 3 (Athwalines).
Author's elaboration



No public space available in the proximity of 200-400 meters

Proximity to the river increasing the risk of flooding

Land surface temperature is compartively low in the proximity of the site

Area comprising largely of residential area, the river edge along with wetland act as a oppotunity

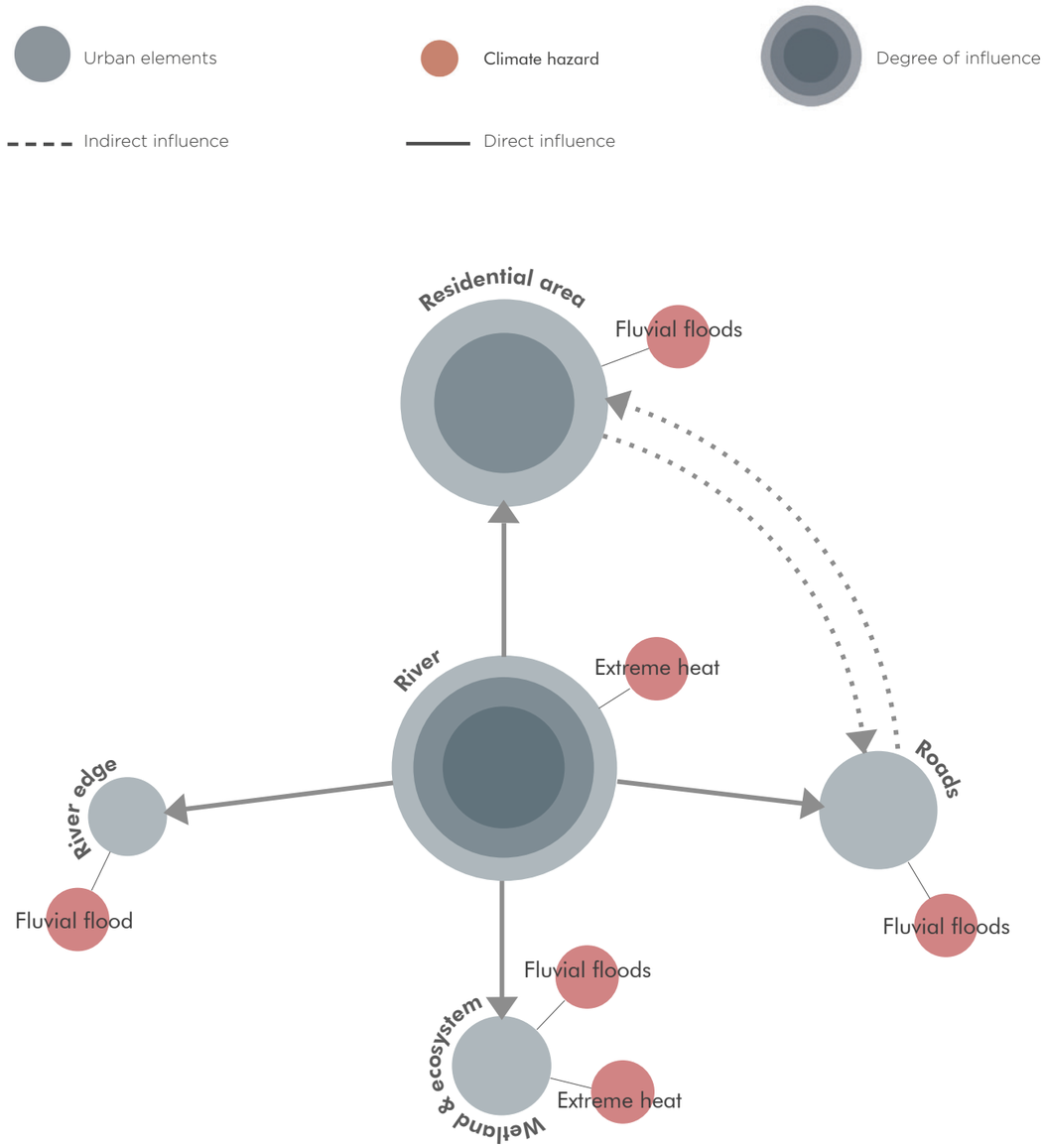


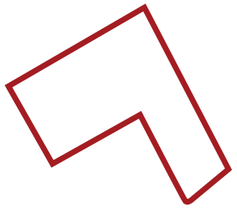
Fig 91. Relationship between various urban element along with their influences and potential climate hazard for public space - 3 (Athwalines).
Author's elaboration

The figure above explains the relationship between various urban elements in context of the present site and in which way they influence each other, making them exposed to multiple climate hazard. The urban elements that act as a major factor in the proximity of site are mainly residential area. The wetland and river edge are sensitive due to the river flood, however, they can be an opportunity while designing the public space.

Public Space - 4 | Piplod

Fig 92. Map showing location of Public space - 4 (Piplod).
Author's elaboration

Key map



Area - 41,488 Sq. m.

The site is located in the Piplod area of Surat city, which is one of the busiest areas. The site is situated just by the primary road, along with commercial zone and residential zone. Since the road acts as a major connecting route to different parts of the city it attracts higher amount of vehicular traffic. Moreover, the river Tapi flows next to the site, which can expose it to the risk of flooding during the monsoon. The site act as a crucial place to be developed as a public space which can designed with various strategies to activate it against various impacts of climate change.

Fig 93. The site is located just along with the primary road having heavy traffic due to commercial zone in the proximity

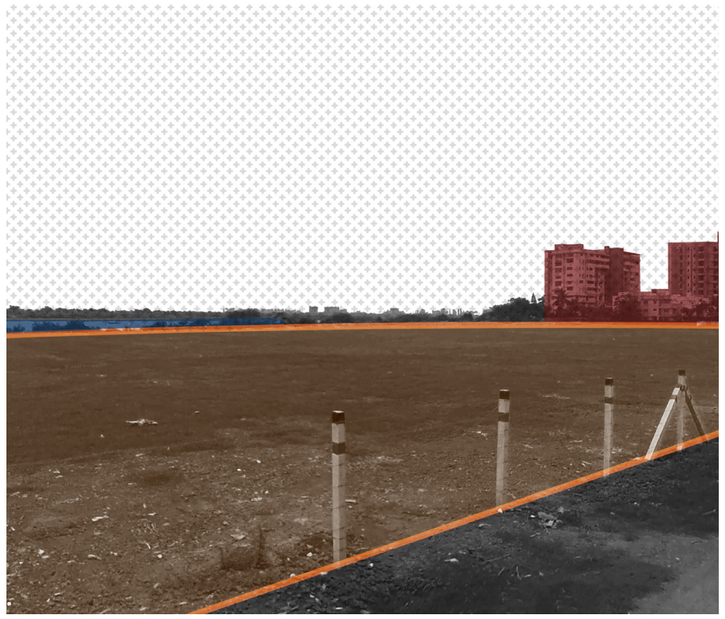
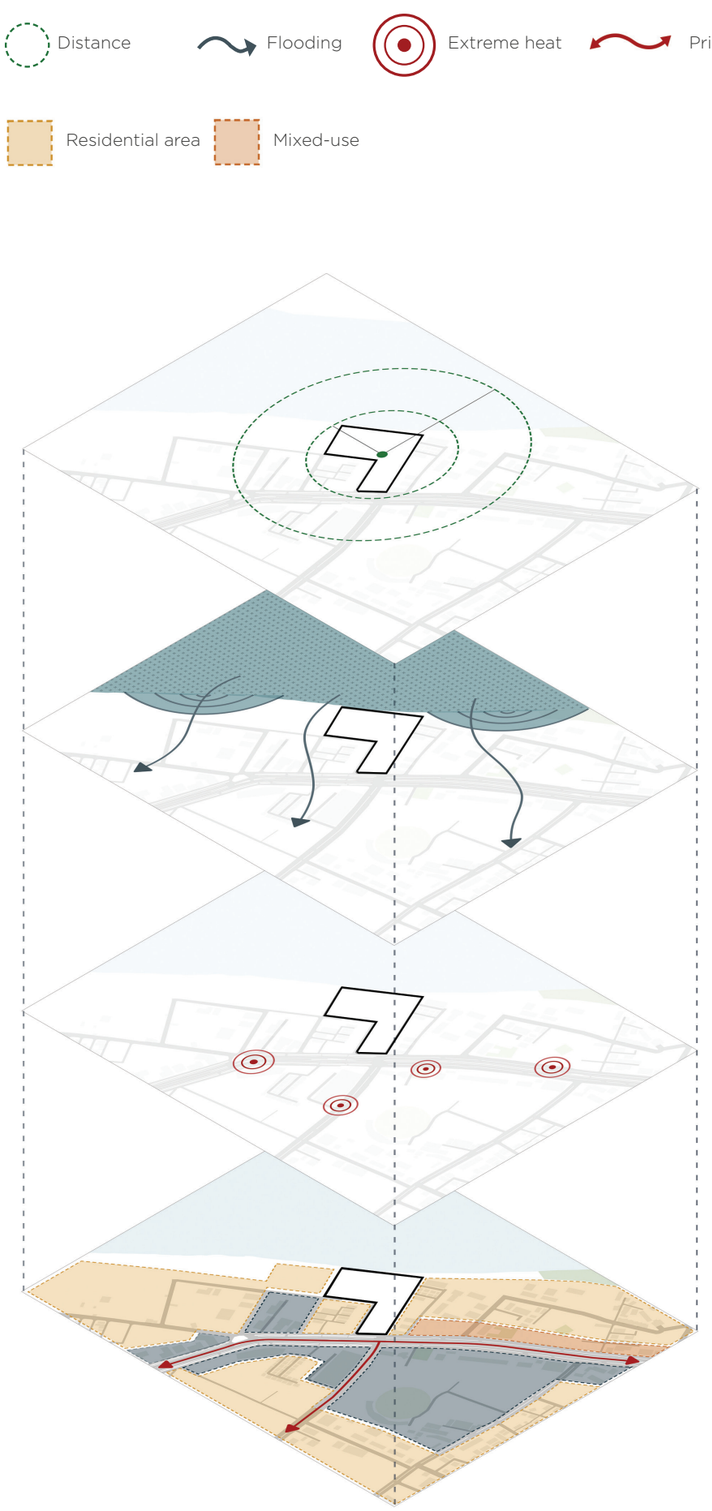


Fig 94. The site has River Tapi just next to it, mkaing it and the residential area near to it expose to flooding during the heavy rainfall

Fig 95. Exploded map showing urban areas, potential hazards & availability of public space - 4 (Piplod).
Author's elaboration



No public space available in the proximity of 200-400 meters

Proximity to the river increasing the risk of flooding

low rate of increase in Land Surface Temperature due to heavy traffic on the roads

The area comprising largely of residential, commercial, as well as mixed-use zones, and having river Tapi on the edge of the site

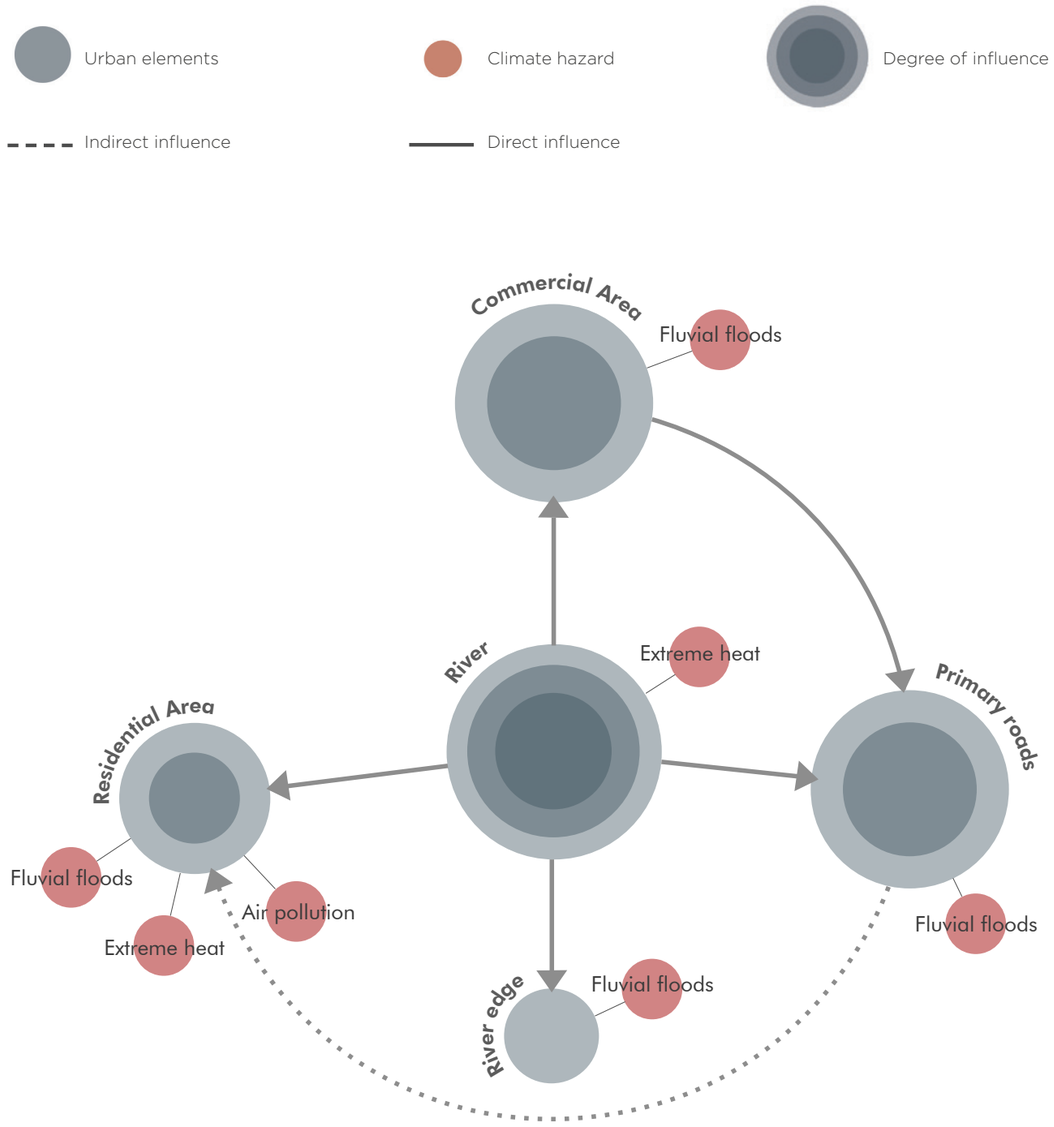


Fig 96. Relationship between various urban element along with their influences and potential climate hazard for public space - 4 (Piplod).
Author's elaboration

The figure above explains the relationship between various urban elements in context of the present site and in which way they influence each other, making them exposed to multiple climate hazard. The urban elements that act as a major factor in the proximity of site are mainly commercial areas, residential area and otehr mixed-use zones. The river flows just next to the site making the are highly exposed to the risks of flooding during monsoons.

Public Space - 5 | Bhatar

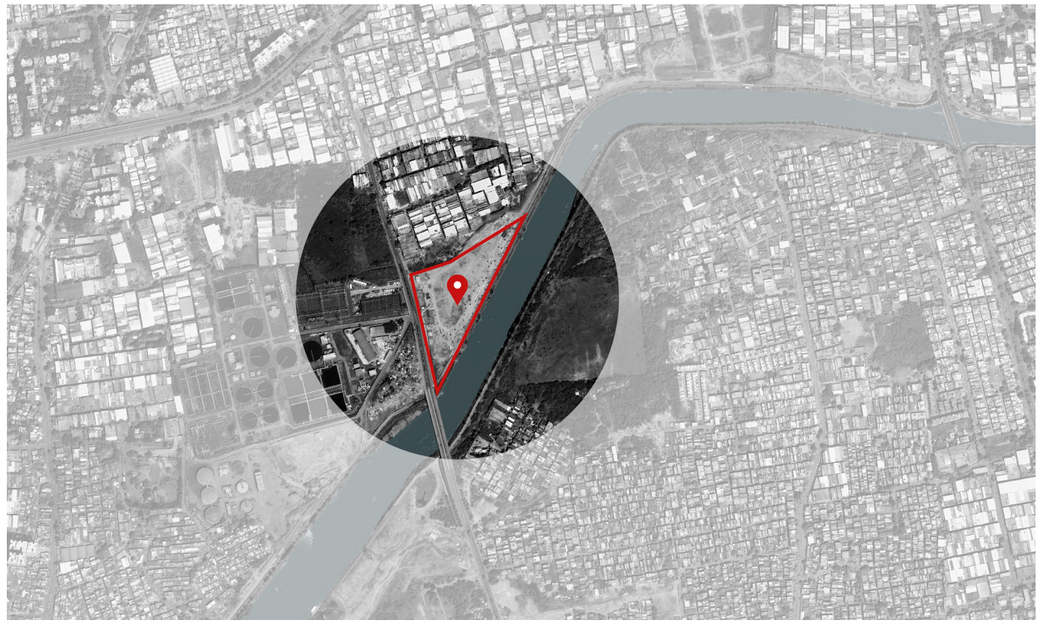
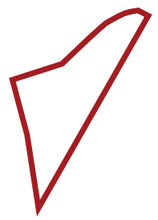


Fig 97. Map showing location of Public space - 5 (Bhatar).
Author's elaboration

Key map



Area - 32,885 Sq. m.

The site is located in the Bhatar area of Surat city. It is surrounded by many small scale industires, due to which the amount of informal dwellings are higher. The creek is passing just next to the site. The site was being used as a waste disposal land, due to which the soi has been polluted. Moreover, the discharge of waste into the creek make the water polluted which further affects the biodiversity as well as the health ofthe residents. The site is situated at the junction with two sides surrouunded by industrial area, one side near to the creek and one is adjusted to the road.

Fig 98. The whole site is currently being used as a dumping area for all types of waste, which is polluting the soil and making it less suitable to grow plants and trees

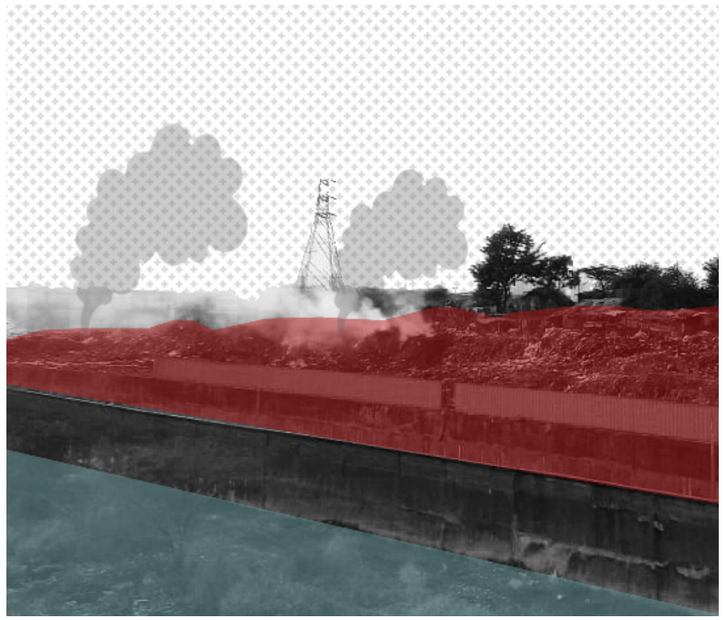
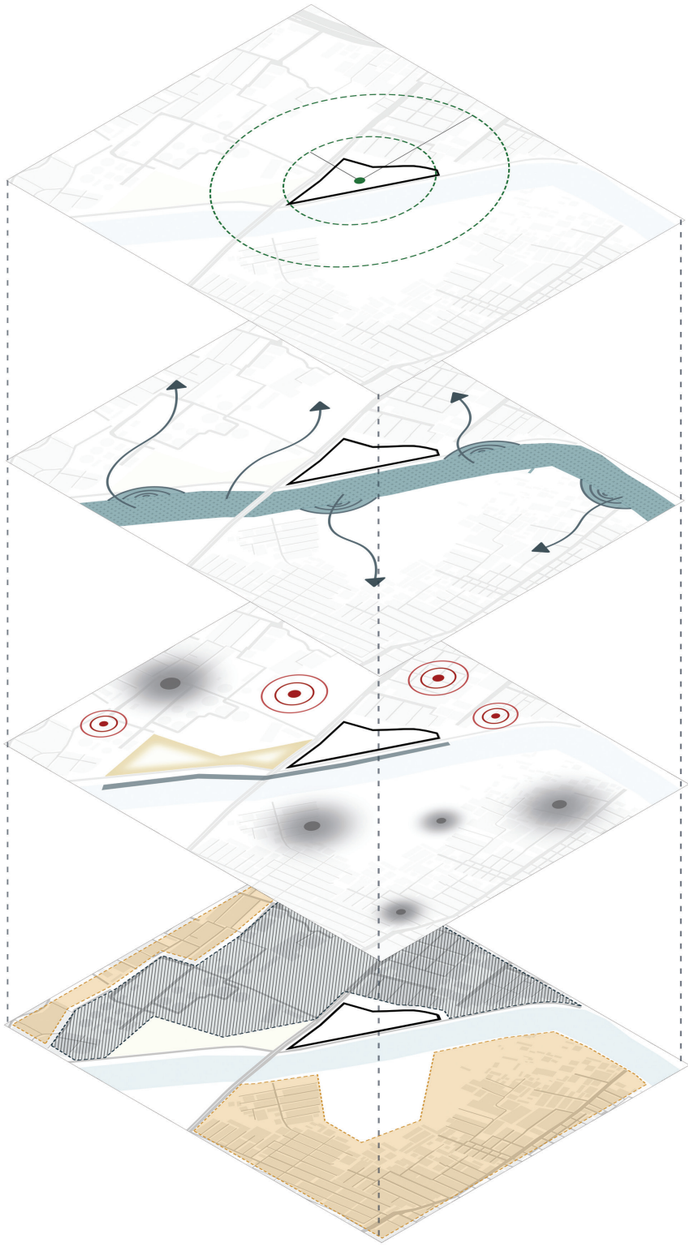


Fig 99. The site is surrounded by various scales of indutries, which pollutes the air due to gas emissions & significantly contribute in increasing L.S.T.

Fig 100. Exploded map showing urban areas, potential hazards & availability of public space - 4 (Piplod).
Author's elaboration

Distance
Flooding
Extreme heat
Air pollution
Industrial area
Residential area



No public space available in the proximity of 200-400 meters

Proximity to the creek increasing the risk of flooding

High land surface temperature and high amount of air pollution due to industries

The are is largely comprises of industrial zone as well as informal dwellings with having sites having waste disposal

Urban elements
Climate hazard
Degree of influence
Indirect influence
Direct influence

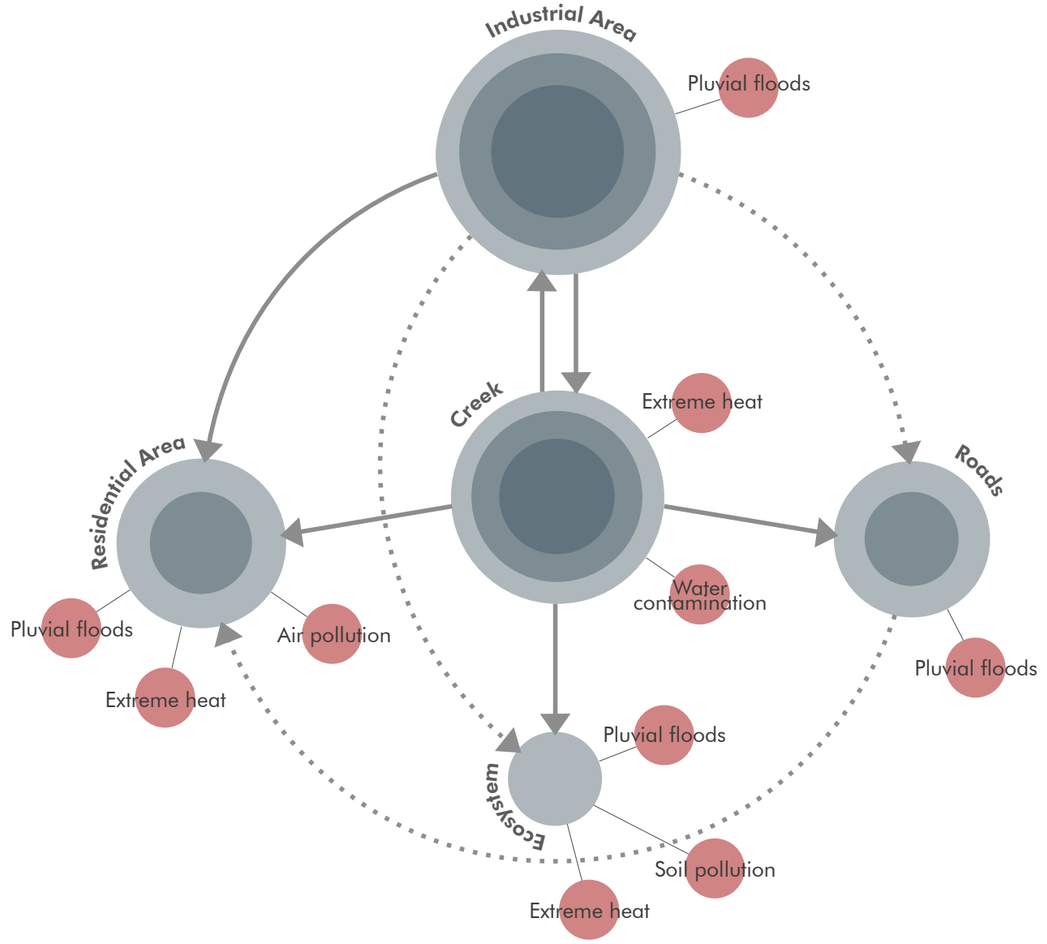


Fig 101. Relationship between various urban element along with their influences and potential climate hazard for public space - 5 (Bhatar).
Author's elaboration

The figure above explains the relationship between various urban elements in context of present site and in which way they influence each other, making them exposed to multiple climate hazard. The urban elements that act as a major factor in the proximity of site are mainly industrial zones & dense urban fabric of informal dwellings. The industries are highly influencing residential & water body, increasing the exposure to climate hazards.

REDESIGNING THE PUBLIC SPACE - 5

(BHATAR)

5.7.

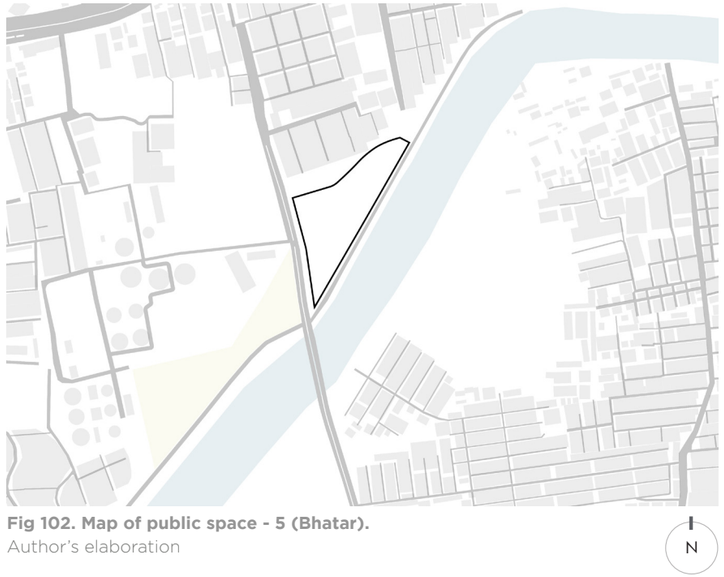


Fig 102. Map of public space - 5 (Bhatar).
Author's elaboration

The chosen case of the given site is crucial to understand how various urban elements influence eachother and increase their vulnerability towards the ongoing issues of climate change. The site is located in the part of city with small scale industries, aditionally, the site itself has a history of being used as a waste dumping and burning site, making it highly vulnerable to multiple environmental issues. The creek flows next to the site is also facing the challenges of water contamination due to discharge of waste from the industries and poor management. Informal dense residential dwellings and encroached areas by the poor also exist in priximity of the site, puting them at the risk of various climatic issues such as floods, extreme heat, air polluton, water related issues as well as those related to health and well-being. Intereaction of these issues with one another exacerbate the negative impacts they have on the urban area.

From theory to practice |
Redesigning the public space

Fig 103. News article.
T. (2021, January 30). Retrieved December 2, 2023, from https://timesofindia.indiatimes.com/city/surat/solid-waste-continues-to-be-dumped-at-closed-bhatar-site/articleshow/80605260.cms

The news article from Times of India (TOI) from Jan-2021 showing how the site was still being used as waste dumping and burning site which is affecting the residents and workers

The proposal by the Surat Municipal Corporation (SMC)

The selected site was being used to dump and burn the tonnes of waste, which was polluting the river as well as affecting the ecology of the surrounding urban areas. In order to prevent these environemtnal issues, SMC proposed to redevelop the site and develop it as a eco-friendly biodiversity park in 2013. The proposal was divided in three phases:

1) First phase was to plant the magroves on the edge of the creek
2) Second phase was to create embarkment around the site to prevent the waste flows towards the water body
3) Third phase was focused on bio-mining the site to clear the soil

Assessing the sensitivity

Industrial zone is dominant factor affecting the site as well as overall area. It contributes in the emissions of gas, attracts higher number of vehicles and discharges waste into the creek. Furhter, affecting the health of residents and quality of the environment, increasing the present climate issues.

Climate Hazard	1	2	3	4	5	
Pluvial floods	●	●	●	●	●	High
Extreme heat	●	●				Low
Air pollution	●					Low
Water cont.	●					Low
Soil pollution	●					Low

Residential area in the context of the site is densly built urban fabric including the informal dwellings due to the presence of industries. The dense built fabric exacerbate the already existing land surface temperature resulting in the creation of UHI. Moreoveer, it also increase the issue of waste disposal.

Climate Hazard	1	2	3	4	5	
Pluvial floods	●	●	●	●	●	High
Extreme heat	●	●	●	●		Low
Air pollution	●	●	●	●	●	Low
Water cont.	●	●	●			Medium
Soil pollution	●					Low

Roads are highly influenced by the industries, attracting larger numbers of vehicles, which significantly increases the amount of vehicular emissions resulting the air pollution causing negative effects on the health of the residents.

Climate Hazard	1	2	3	4	5	
Pluvial floods	●	●	●	●	●	High
Extreme heat	●	●	●			Medium
Air pollution	●	●				Low
Water cont.	●					Low
Soil pollution	●	●	●			Medium

Creek is located just next to the site. However, due to the history of waste disposal on the site, it has been continuosly been polluted along with waste discharge from the industries. During the season of heavy rainfall it causes flood which affects the whole urban area nearby.

Climate Hazard	1	2	3	4	5	
Pluvial floods	●	●	●	●	●	High
Extreme heat	●	●	●			Medium
Air pollution	●	●				Low
Water cont.	●	●	●	●	●	High
Soil pollution	●	●	●			Medium

Ecosystem is highly affected due to soil pollution, increasing temperature as well as water contamination, making it difficult for plats and trees to grow due to bad quality of soil.

Climate Hazard	1	2	3	4	5	
Pluvial floods	●	●	●	●	●	High
Extreme heat	●	●	●	●		High
Air pollution	●	●	●			Medium
Water cont.	●	●	●	●		High
Soil pollution	●	●	●	●	●	High

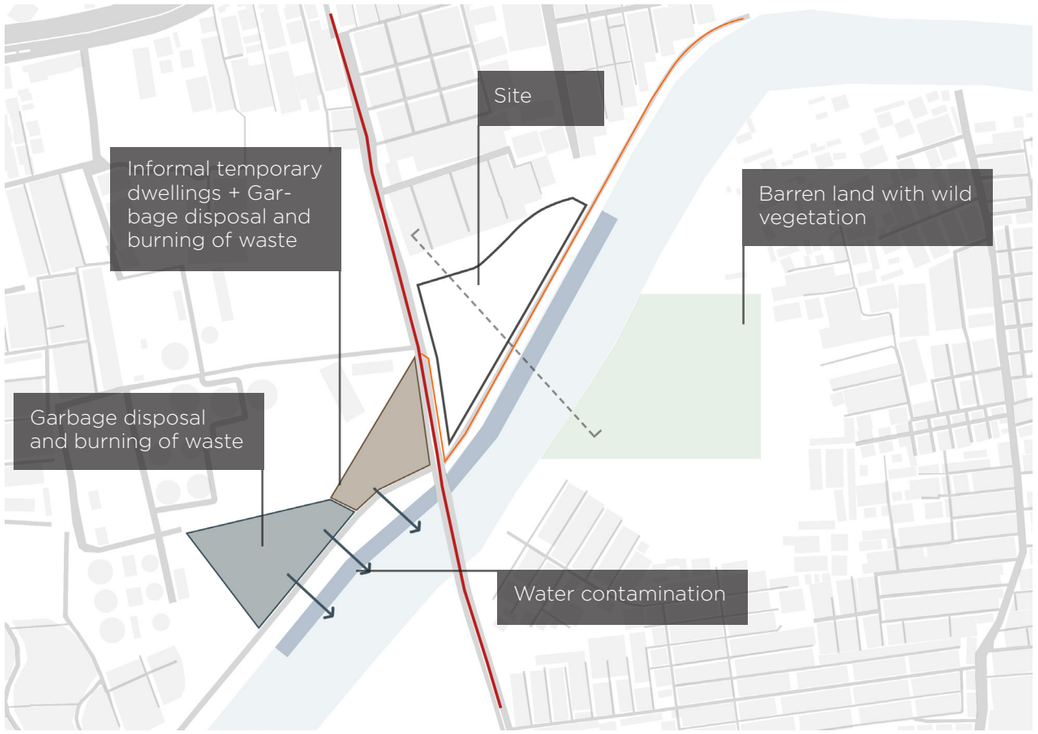


Fig 104. Map of public space - 5 (Bhatar) with the context.
Author's elaboration

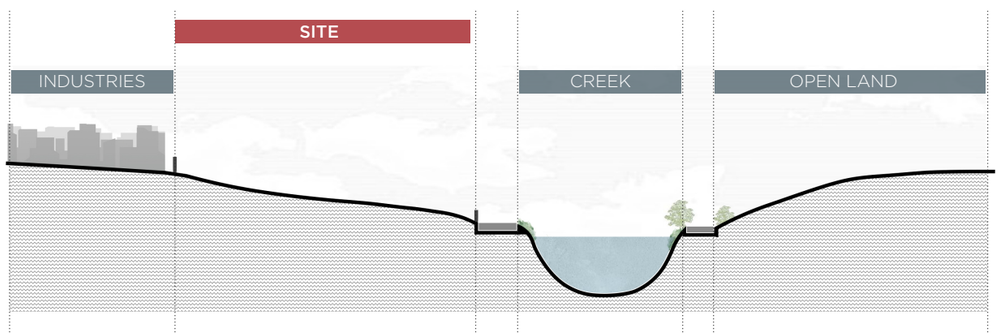


Fig 105. Section of public space along with its context.
Author's elaborationr

Fig 106 - Improving the connections
The site with better connections and pathways for the people, while creating barrier towards industrial zone

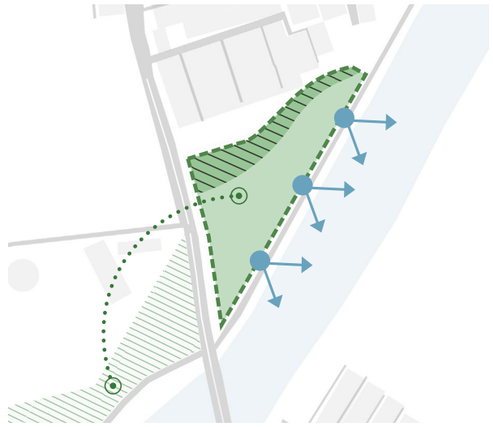


Fig 107 - More natural areas
The site with more natural areas along with better connection to the surroundings natural areas to support the ecology

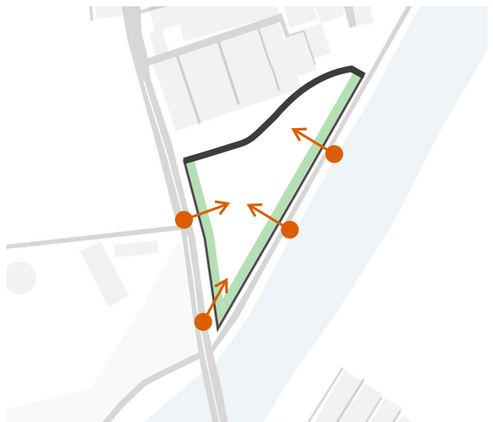


Fig 108 - Access points and Green nodes
Improving the accessibilty and providing green nodes on the site will help the community to engage more with nature

Fig 109 - Various ecosystem services
Providing multiple ecosystem services on the site will also benefit the surrounding areas as well as the well-being of people

5.8.

Fig 110. Conceptual zoning.
Author's elaboration

From theory to practice |
Approach to the design

Dense vegetation | Planting densely populated trees on the upper part of the site will act as a buffer between indeustrial zone and site. Helping in carbon sequestration, air purification, and regulating micro-climate

Detention lawn | Green park at the middle of the site act as a detention area that absorb the runoff water during the period of heavy rainfall acting as a temperoary storage of water

Retention pond | Water body at the lowest point of site acts as point of collection that contains water coming from higher points of the site, which also contains plants that treats the water

Retention pond | Inner part of the site that have plants according to the local biodiversity, becoming habitat for various wildlife

Urban farm | Part of the site near to biodiversoty park as an urban farm helps grow crops, benefiting community

Rain garden | Along with biodiversity park rain garden helps in infiltrating water and acts as a habitat for wildlife

Permeable cycle parking | Cycle parking with permeable paving

Gravel area | Helps in filtrating water and acts as an activity area

Riparian buffer | Vegetation along the water stream

Pathways | Pathways with permeable paving

Cycle & pedestrian paths | Allocation of pedestrian & cycle track on the edge of site

Masterplan

Fig 111. Masterplan.
Author's elaboration

List of ecosystem services

Provisioning Services	Regulating Services
Cultivation areas	Rain garden
Clean water	Bioswales
Reusable water	Detention lawn
Plants and trees attracting various types of wildlofe	Retention pond (Cleaning water)
	Trees and plan improving air qaulity
	Carbon storages

Cultural Services	Supporting Services
Commnity green areas	Water manaement
Green spaces for elderly	(Upper part of site --> Detention lawn Retention pond
Children's area	Low carbon footpritn
Recreational facilities	
Cycle paths	
Pedestrian pathways	

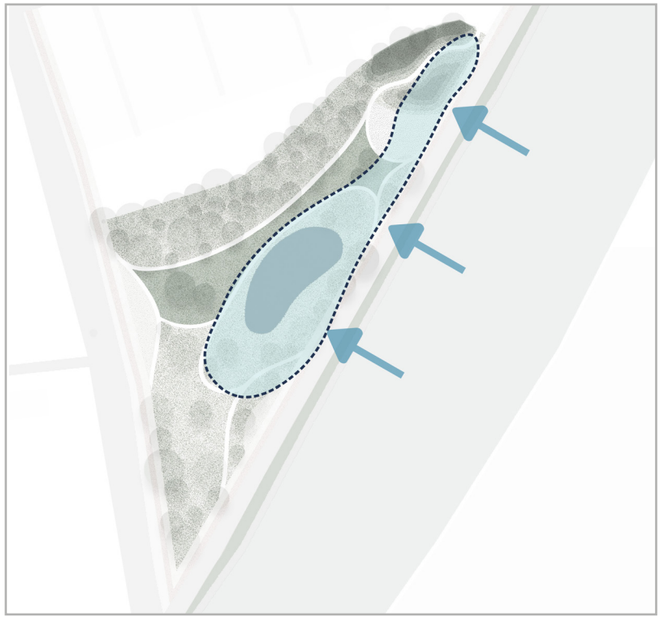


Fig 112 - floodplain protection aganst floods

Author's elaboration

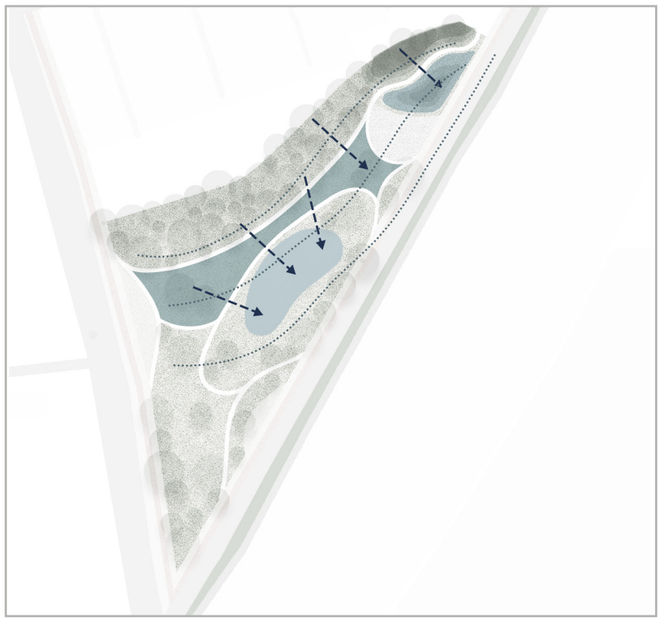
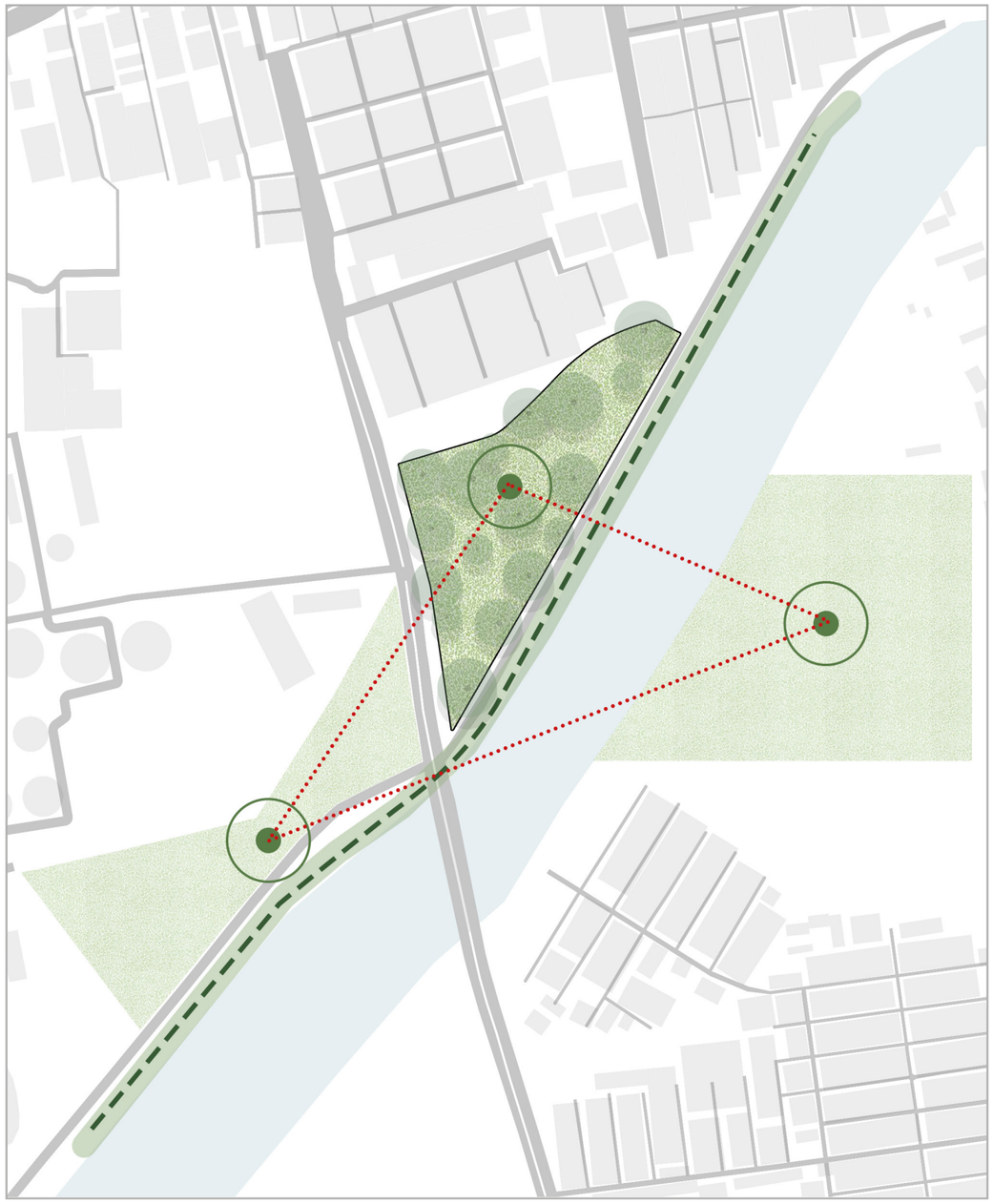


Fig 113 - Water system inside the site

Author's elaboration

Fig 114 -Future sceanrio about developing green connection in urban area

Author's elaboration



CHAPTER

06

CONCLUSION

How redesigning public spaces in urban areas will help in adapting cities faster to the effects of climate change?

Theoretical backgrounds
Urbanization, climate change and public spaces

Analyzing the best practices
Analyzing successful examples of adaptive public spaces through comparative analysis

Applying theories into practice
An approach to the design of adaptive public spaces in the city of Surat to answer the research question

Perosnal reflections and future possibilities

Theoretical backgrounds

Urbanization, climate change and public spaces

The integrated analysis of theories, starting from urbanization to adaptation towards climate change, highlights the significant interrelation between urban planning and climate change, clearly stating the importance of urban public spaces in dealing with climate change issues in urban areas. The theories about urbanization and climate change explain how urban areas worldwide are rapidly expanding, consequently putting them at a higher risk of escalating climate-related issues. Furthermore, theories concerning adaptation to climate change speculate about the need to acknowledge the urgency of addressing climate change at the local level by integrating adaptation strategies into local urban planning policies. However, urban public spaces emerge as an essential means to build urban resilience within the foundation of these theories, which can effectively benefit the environment and the community. Redesigning urban public spaces with a focus on adapting them towards climate change can significantly assist in dealing with urban heat islands, thermal discomfort, and stormwater-related issues. In a nutshell, theories strongly suggest the importance of redesigning public spaces by integrating adaptation strategies with current urban planning policies, which can remarkably lead the cities faster towards the pathway of more sustainable and climate-resilient cities, with further- positive effects on national and global levels.

Analyzing the best practices

Analyzing successful examples of adaptive public spaces through comparative analysis

Successful examples of adaptive public spaces

Assessing various case studies worldwide with varied contexts explained the transition of theories into practice while redesigning the public spaces for climate change adaptation, stating the significance of urban public spaces in adapting cities faster towards climate change.

Results of comparative analysis

The comparison analysis findings within these examples of adaptive public spaces highlighted various approaches currently being used in planning and designing public spaces to address various types of climate impacts. It clearly stated how public spaces in different contexts were designed to serve the community and deal with the issues related to thermal comfort, stormwater, and urban heat islands, creating a balance in an urban area.

Insights from detailed studies

I was delving deeper into a few selected case studies that unfolded the process of turning theories into tangible aspects and valuable strategies, highlighting the significance of integrating nature-based solutions in creating adaptive and climate-resilient public spaces. To conclude, understanding the best cases from the world assisted in delving deeper into activating urban public spaces for climate change through innovative adaptation strategies.

Applying theories into practice

An approach to the design of adaptive public spaces in the city of Surat to answer the research question

The central question of the thesis revolves around the idea that redesigning public spaces can effectively lead cities to adapt faster to the impacts of climate change. Remarkably, this understanding was better understood by applying theories, learnings from the case studies, and extracted strategies in the case of Surat (India). The city of Surat is vulnerable to multiple climate change effects, which provides a better opportunity to apply the theoretical understanding. Analyzing the city's current scenario in the climate change field helped identify vulnerabilities of various urban areas and the urgent need to integrate adaptation strategies into the planning and designing of public spaces. Moreover, theories and studying best practices across the globe helped establish a methodology to recognize vulnerable public spaces, analyze their sensitivities, and redesign them by integrating various adaptation strategies to activate public spaces to deal with climate change. In conclusion, the case of redesigning public space for climate change in Surat (India) states that adapting the urban public spaces by integrating nature-based solutions, green infrastructures, and community-centred design can significantly help in fostering adaptation practices at a smaller scale, which can considerably adapt cities faster towards climate change, along with upscaling their benefits on state, national to global scale.

Personal reflections

Surat has consistently remained at the forefront in innovations and progress, starting from being acknowledged as India's second cleanest city, a 'green city' as well as its recognition as the 'diamond city' shows the city's commitment towards prosperity in various aspects and how it is playing a pivotal role in the development of the overall nation. Surat is my hometown, and I have continuously observed the city's resilience in dealing with various climatic challenges it frequently faces. The city has always tried to adapt and evolve through various climatic issues, including flooding, air pollution, extreme heat, and severe storms. However, climate change adaptation strategies must be better integrated into urban planning policies, leaving a gap in climate change adaptation practice. I believe that applying the central concept of this thesis about looking at a smaller scale in urban areas, specifically in the planning and designing of public spaces, has significant potential in putting the city of Surat at the forefront of the practice of climate change adaptation in India. By integrating effective adaptation strategies along with nature-based solutions and green infrastructures in adapting public spaces of Surat towards climate change, the city can notably transition towards one of India's first climate-resilient cities, becoming a model for other cities to emulate. In a nutshell, redesigning the public spaces of Surat for climate change can make the city more sustainable and climate-resilient, inspiring other urban centers in India and globally.

Future possibilities

As a future possibility, the thesis can be applied in the development of the city in the pathway towards climate change adaptation. The whole development can be implemented in various phases. The framework of the thesis can be utilized in assessing various urban areas of the city along with their exposure to different impacts of climate change, which can help in identifying potential public spaces to be activated to deal with the challenges, which can adapt various urban public spaces of the city towards effects of climate change. The thesis also suggests establishing connections between various adaptive public spaces in different neighbourhood neighbourhoods, which can be extended by connecting green public spaces across the city. They were transitioning cities towards greener, sustainable, and climate-adaptive cities. Ultimately, it can create numerous green connections of public spaces in the city, which can combat various climatic challenges that the city faces, creating a balance between the city's people and nature.

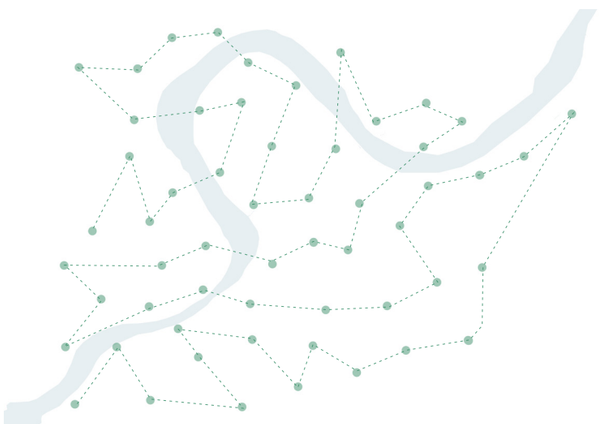


Fig 115. Abstract map showing future scenario of esblished connection between various adaptive public spaces across the Surat city

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// ACKNOWLEDGEMENTS

As I stand here at the end of this journey full of learning, I would like to acknowledge and express my gratitude to all the individuals who walked alongside me as a pillar of unwavering support, offering motivation and encouragement at every turn.

First and foremost, I want to sincerely thank my supervisor Prof. Ombretta Caldarice, for this remarkable opportunity and for her invaluable guidance, expertise, patience, and feedback. This journey would not have been possible without her continuous support.

To my loving family, to my Mom and Dad, thank you for always believing in me even when I don't and supporting me in everything I do with all your heart. My amazing brothers, Kevin and Parth, thank you for always being there as my constant support. Thanks to you four, for being the source of my strength and to whom I owe everything for who I am today.

To Hely, Manan and Radhe. Not just friends but my family whom I have found on my way in this life. Thanks to Manan and Radhe, for always supporting me silently and giving me the inspiration every time I needed it, for every late-night call when we were just there for each other as a support while working on our things. Thank you, Hely, for always believing in me, for always motivating me in everything, and for 'Proud of you' text every morning which has always kept me going.

To Anjali. Thank you for making me feel like home here in Turin, for all the constant support, for all the motivations, help and for every happy moments. Your presence made this journey less stressful, especially, the last few months were easier with your support. Thank you for always being the backbone and always being there despite of all.

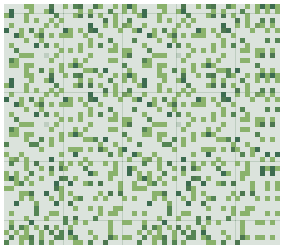
To all my colleagues and my friends here in Turin. Thank you for all the fun, stress, happy, sad, wonderful and unforgettable moments.

To Bruna and Kai. Amazing people I met here in Turin. Thank you Kai for always supporting me, motivating me, and for all the studio work, all the conversation, and for every moment. Thanks Bruna, for always inspiring me in every step, for always showing a positive side to everything, and for always helping, I wish you the best sunsets. I am very grateful for both of you for your constant support and help during this journey.

To Jaysheel, thank you for being family here, for always supporting me, motivating me, and helping me even after being far away, for all the wonderful moments we have shared.

To Alex, thank you for always motivating me, for believing in me and for making me feel light and happy in all those stressful moments. Thank you for always being a person to whom I can freely go to discuss and guidance.

THANK YOU ALL



RETHINKING URBAN PUBLIC SPACES FOR CLIMATE CHANGE

Adaptation strategies for Surat (India)