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An Analytical Study of Urban Tissue Design Strategies for Climate Change Mitigation and Adaptation

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Abstract. This study investigates alternatives for urban tissue design that can effectively mitigate and adapt to climate change. The research centers on urban regions in Egypt, examining various urban tissues to evaluate their effectiveness in enhancing thermal comfort and adapting to challenging climatic conditions. By employing comparative analytical methodology, the paper reviews multiple case studies on urban tissue design techniques aimed at climate change mitigation and adaptation. This comprehensive analysis provides valuable insights into the efficacy of different urban design strategies for fostering resilient and sustainable urban environments. The study examples analyze crucial factors of urban tissue, including building height, street direction, and incorporation of green spaces according to climatic factors. The analytical study shows the effectiveness of optimal urban layouts, reflecting and permeable materials, green roofs, and walls in reducing the urban heat island phenomenon and enhancing energy efficiency. The results highlight the impact of integrating climate-responsive solutions into urban planning to promote sustainable and comfortable environments. This study offers significant perspectives for architects, urban planners, and legislators who are seeking to enhance metropolitan environments by efficiently dealing with issues caused by climate change.

Keywords: Urban Tissue Design, Climate Change, Mitigation and Adaptation, Thermal Comfort.

1 Introduction

The accelerating pace of climate change necessitates a critical reassessment of urban area design, underscoring the imperative for flexibility to contend with the uncertainties brought about by rapid shifts in both natural and built environments.[1] Modern cities face escalating vulnerabilities to climate change-related risks, including overheating, intensified rainfall, rising sea levels, and devastating storm surges. Consequently, it is essential to develop adaptable urban tissues at the macro (city) scale to effectively mitigate these impacts. This strategic approach encompasses deploying robust natural hazard defenses to protect against floods, fires, and storm surges, while also minimizing building exposure to extreme temperatures and overheating.[2] By integrating resilience and adaptability into urban design, cities can better safeguard infrastructure, enhance public safety, and sustain their functionality in the face of climate-induced challenges.[3]

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The ongoing process of urbanization and climate change are causing urban temperatures to rise. It is important to make collective efforts to prevent temperature increases from exceeding 2°C to avoid future climate-related calamities [4]. The urban heat island (UHI) effect, which is intensified by factors such as dark surfaces and decreased vegetation, worsens the occurrence of heat stress in urban areas [5]. Studies indicate that heat waves, particularly in areas that are not accustomed to extreme temperatures, provide substantial health hazards, underscoring the necessity for focused adaptation methods [6].
The study investigates the relationship between urban tissue and climate change, focusing on the unplanned development of urban tissues. It highlights the mutual interactions between urban tissues and climate, highlighting the need for effective urban design strategies for climate change mitigation and adaptation. The research aims to understand the interplay between urban tissue and climate change.
This study compares different methods of urban tissue design that have been used to reduce and adjust to climate change. The study examines several studies publications on urban tissue design approaches to identify key strategies and characteristics that facilitate the effective incorporation of climate adaptation solutions. The research highlights two main approaches: firstly, incorporating climate change adaptation as a central focus in participatory urban planning processes to encourage dialogue, contemplation, and consciousness, and secondly, integrating climate considerations into all proposed urban initiatives, showcasing how strategies like tree planting and energy-efficient building rehabilitation improve climate resilience.
The study seeks to emphasize novel approaches and exemplary techniques in urban fabric design to foster climate mitigation and adaptation. The objective is to provide stakeholders, such as architects, lawmakers, and urban planners, with the necessary resources to develop urban settings that are both resilient and sustainable, capable of effectively addressing the difficulties presented by climate change. To overcome this gap, the following research objectives have been established:
The objective is to assess the extent to which cities are integrating climate change mitigation and adaptation measures into their urban infrastructure policies. To analyze the main factors contributing to this integration, or the absence thereof. This study commences with a concise overview of the impacts of climate change and proposes strategies for designing urban infrastructure to accommodate these changes. Afterwards, it examines alterations to urban structures that can alleviate the impacts of climate change. Ultimately, it examines pertinent previous studies to develop a logical strategy for constructing urban structures that can efficiently adjust to evolving climatic situations.

2 Climate change

Climate change refers to significant, long-term changes in the global climate patterns, primarily driven by human activities such as burning fossil fuels, deforestation, and industrial processes. These changes result in rising global temperatures, extreme weather events, and shifting ecosystems, posing serious threats to biodiversity, human health, and economies worldwide [7]. Addressing climate change requires urgent global efforts in mitigation and adaptation strategies to reduce greenhouse gas emissions and enhance resilience.

2.1 The Current State of the Climate in Egypt

Egypt, characterized by its hot arid climate, faces significant climatic challenges that impact its ecology, economy, and population. Key aspects of the current climate include:

Extreme Temperatures: Egypt experiences consistently high temperatures, with summer averages in Cairo reaching 35.7°C and often exceeding 40°C. Winter temperatures can drop to around 7°C in some areas [8].

Humidity Levels: Relative humidity varies seasonally, with Cairo experiencing around 62% in summer and 50% in winter, affecting overall comfort [9].

Climate Change Impacts: Rising Temperatures: Climate change is projected to increase average temperatures by 2-4°C by the end of the century, intensifying heat stress, particularly in urban areas like Cairo. The urban heat island effect further exacerbates these challenges, necessitating green infrastructure, improved building materials, and better urban planning [10].

Addressing Egypt's climate challenges requires a collaborative effort focused on adaptation and resilience, including sustainable water management, climate-responsive urban planning, and renewable energy adoption. By understanding and addressing these issues, Egypt can better protect its environment, economy, and population from the ongoing and future impacts of climate change.

2.2 Global Warming Potential (GWP)

The climate has been warmed by human activities at an unprecedented rate. The global surface temperature will continue to rise until at least the middle of the century, regardless of the emissions scenarios analyzed. Unless significant reductions in CO_2 and other greenhouse gas emissions are achieved in the next few decades, global temperatures are projected to surpass the 1.5°C and 2°C thresholds during the 21st century [11]. Fig. 1 displays the observed and simulated increases in global surface temperature (annual average) related to the period of 1850-2020 [12]. The Global Warming Potential (GWP) was created to facilitate the assessment of the global warming effects of various gases by enabling comparisons. More precisely, it quantifies the amount of energy that the emissions from 1 ton of gas absorb during a specific timeframe, compared to the emissions from 1 ton of Carbon Dioxide [13].

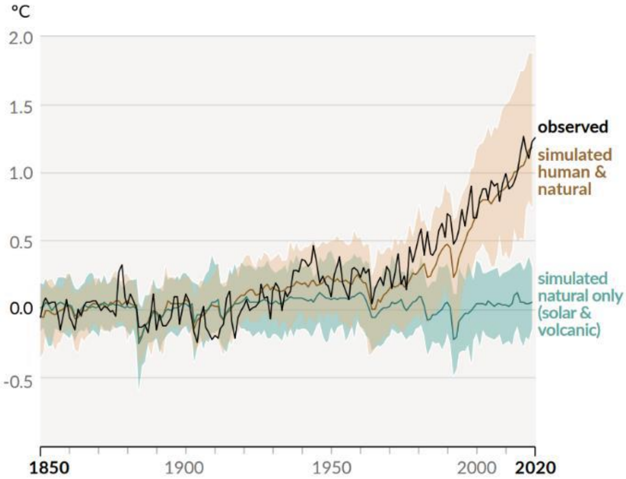


Fig. 1. Global surface temperature relative to 1850-2020 Source, IPCC, 2021 [10]

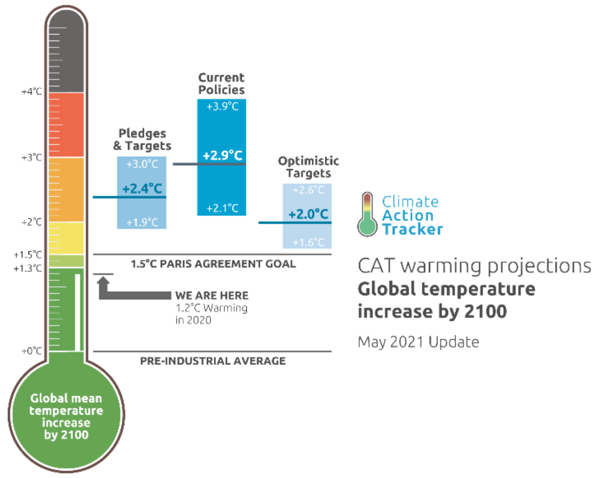


Fig. 2. Global mean temperature relative to 2100 Source, Climate Action Tracker [3]

2.3 Emissions of Greenhouse Gases (GHG)

The primary contributor to greenhouse gas emissions resulting from human activities is the combustion of fossil fuels for the purposes of generating electricity, providing heat, supporting industrial processes, and facilitating transportation [14]. Each increment of CO_2 emissions contributes to global warming, with a direct correlation between the total CO_2 emissions and global warming for five specific scenarios until the year 2050 (Fig. 3). The future cumulative emissions of CO_2 vary among scenarios and play a crucial role in determining the extent of global warming caused by human activities [15]. These activities impact all main components of the climate system, with some effects taking place over decades and others becoming irreversible over millennia.

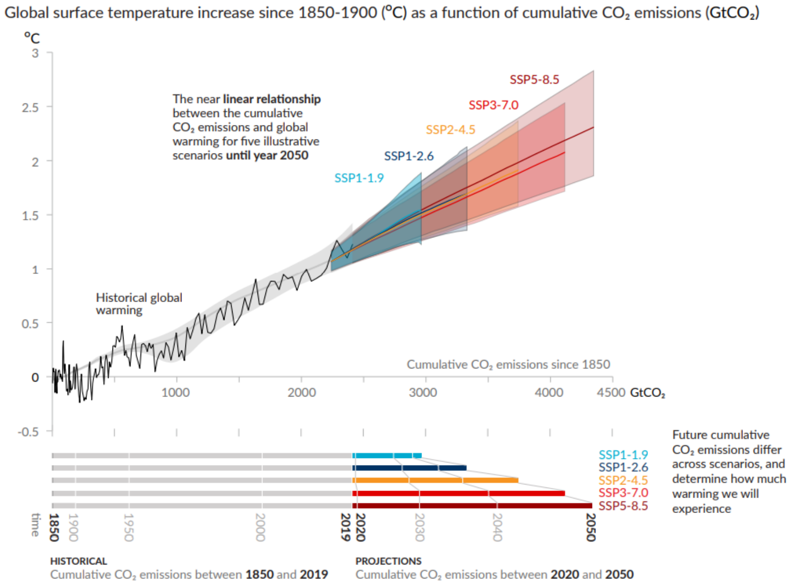


Fig. 3. CO_2 emissions and global surface temperature under five different scenarios by the year 2050. Source, IPCC, 2021 [10]

2.4 Urban Heat Island (UHI)

An urban heat island refers to an urban or metropolitan area that experiences significantly higher temperatures compared to the surrounding rural areas. This temperature difference is mostly caused by changes in land surfaces and human activity. The term "Urban Heat Island Effect" describes the phenomena that causes a temperature difference, particularly at night [16] (Fig. 4). Cities in hot climates are becoming more problematic due to issues such as traffic congestion, air pollution, and worsening microclimates, particularly the increasing impact of urban heat island (UHI) effects [17]. Figure 5.

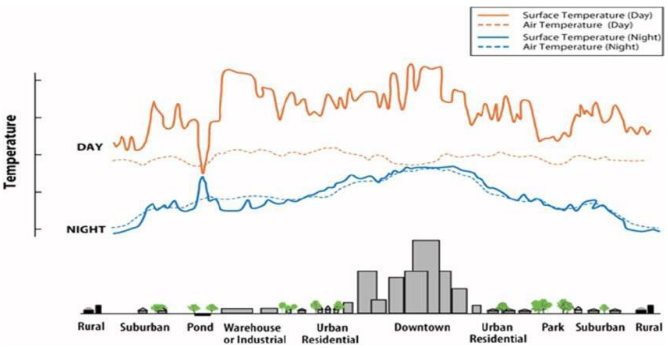


Fig. 4. Typical Urban Heat Island Profile Source, U.S. EPA (Environmental Protection Agency), September 2016 [19]

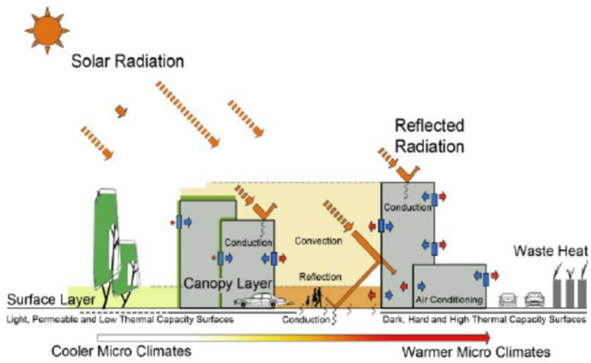


Fig. 5. The UHI effect in cities is influenced by urban structure, topography, land-cover, and metabolism. Source,www.researchgate.net

3 Integration of Mitigation and Adaptation in urban climatology

The integration of mitigation and adaptation strategies is crucial in addressing the impacts of climate change. Mitigation strategies aim to reduce carbon emissions and the source of the problem, while adaptation strategies focus on reducing the impacts [18]. Urban climatology plays a crucial role in addressing these impacts, as cities face unique challenges such as increased temperatures, altered precipitation patterns, and intensified weather events. Both mitigation and adaptation strategies are essential for managing the massive and urgent climate crisis [19].

Mitigation and adaptation activities interact and frequently enhance one another. Green roofs have the dual benefit of mitigating energy use and providing improved insulation, hence reducing heat stress [20]. To achieve effective urban climatology practices, it is necessary to use an integrated approach that incorporates several techniques to develop cities that are sustainable and resilient.
Urban climatology is a holistic strategy to combatting climate change in urban environments, incorporating both mitigation and adaptation techniques. Cities can improve their ability to handle the effects of climate change by decreasing urban heat islands and increasing urban resilience. Building climate-resilient urban ecosystems requires the integration of effective urban planning, the establishment of green infrastructure, and active community engagement [21].

4 Urban Form to Mitigate and Adapt to Climate Change

The urban tissue of cities plays a crucial role in both reducing the negative consequences of climate change and adapting to its unavoidable impacts. By carefully planning and constructing the physical layout and structures within metropolitan regions, cities can significantly influence microclimates and thermal comfort for their citizens [22]. Urban planning is pivotal in this regard, as it can mitigate climate change effects by integrating green spaces, using reflective building materials, and optimizing street orientations. These measures enhance airflow, reduce heat absorption, and promote evapotranspiration, thereby reducing heat island effects. Such strategic planning not only mitigates climate change impacts but also bolsters urban resilience, providing sustainable and comfortable environments for residents [23].

4.1 Green Infrastructure Integration:

Green urban infrastructures, both public and private, are crucial for mitigating urban climate and improving thermal comfort. Technologies like green roofs and walls reduce energy consumption, reduce solar radiation absorption, and mitigate the Urban Heat Island effect. They also enhance thermal insulation, acoustic insulation, ecological preservation, summer temperature mitigation, rainwater runoff attenuation, and aesthetic enhancement, ultimately increasing property values [24].

- **Green Spaces**: Urban green spaces, such as parks, gardens, and greenways, play a crucial role in reducing the Urban Heat Island (UHI) effect, improving air quality, and enhancing the aesthetic appeal of urban areas. These spaces provide shade, evapotranspiration, and a break from the urban environment, thereby reducing the UHI effect and promoting biodiversity by creating habitats for various species [25].
- **Green Roofs and Walls:** Urban Heat Island (UHI) is a significant climate change issue affecting urban environments. Green roofs and walls can mitigate this by providing thermal insulation, reducing heat absorption, and promoting evapotranspiration, lowering surrounding temperatures. This reduces energy consumption and greenhouse gas emissions, improving the sustainability and resilience of urban tissue in these challenging urban environments [26].

4.2 Reflective and Permeable Materials:

Reflective and permeable materials play a crucial role in mitigating and adapting to climate change in urban tissues.

- **Reflective Surfaces**: Reflective materials on rooftops and pavements can significantly reduce heat accumulation in urban areas, reducing the impact of urban heat island phenomena and reducing the need for cooling energy. These surfaces reflect more sunlight and absorb less heat than traditional materials, improving thermal comfort and livability. Incorporating reflective surfaces into urban design can contribute to global efforts to combat greenhouse gas emissions [27].

- **Permeable Pavements**: These surfaces can promote the absorption of water, causing lower surface temperatures and increased replenishment of groundwater. In addition, they assist in the management of rainwater, so mitigating the potential for urban flooding [27].

4.3 Optimized Urban Layouts:

Efficient urban designs are crucial for adapting to climate change. By optimizing natural ventilation, promoting green spaces, and integrating reflective materials, cities can reduce heat absorption and improve thermal comfort. Optimal street and building alignment also enhance air circulation and cooling. Sustainable transportation and energy-efficient infrastructure also contribute to urban resilience [28].

- **Street Orientation and Building Heights:** Optimizing wind flow through the design of streets and buildings can enhance natural ventilation, hence reducing dependence on artificial cooling. Regular building heights and carefully designed roadway layouts enhance air circulation and promote effective elimination of heat [29].
- **Dense, Mixed-Use Developments**: Creating compact, diverse urban development's decreases the requirement for extensive transportation infrastructure, which decreases greenhouse gas emissions. Additionally, these regions often exhibit a higher degree of pedestrian accessibility and support the use of bicycles, thereby encouraging environmentally friendly transportation alternatives [30].

5 Scope of the Study:

This study analyzes urban tissue design strategies that are specifically geared to mitigate and adapt to climate change in hot, arid regions such as Egypt. The work focuses on the fundamental elements, which are crucial and essential for investigation.

6 Methodology:

The methodology of the study "An Analytical Study of Urban Fabric Design Strategies to Mitigate and Adapt to the Effects of Climate Change" involves conducting an analytical comparison of six research papers that focus on urban fabric design and have similar climatic scopes. The objective of the study is to identify and evaluate effective urban fabric design strategies by integrating both mitigation and adaptation strategies for climate change.

This technique will offer an effective framework for assessing urban fabric design strategies and their impact on mitigating and adapting to climate change. It will ultimately result in significant insights and recommendations for developing resilient and sustainable urban environments.

The key aspects of the research consist of:

6.1 Assessment of Urban tissue and Design:

- Evaluation of six neighborhoods with different urban tissues to investigate the influence of diverse urban designs on thermal comfort.
- Analysis of urban elements such as building layouts, street orientations, densities and vegetation.

6.2 Thermal Comfort Evaluation:

- Utilization of urban design simulation software to simulate and analyze the urban environment.
- Examine methods used to assess thermal comfort conditions, including microclimatic models.

6.3 Climate Change Mitigation and Adaptation Strategies:

- Identification and analysis of diverse mitigation and adaptation strategies.
- Factors like vegetation density, permeable pavements, roof and wall reflectivity, and urban canopy alterations should be considered.
- Assessment of the combined effects of these factors on temperature reduction and thermal comfort.

6.4 Comparative Analysis:

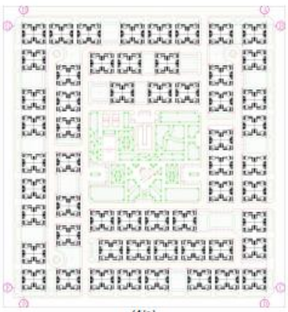
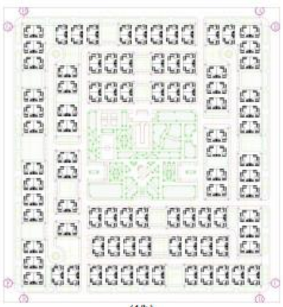
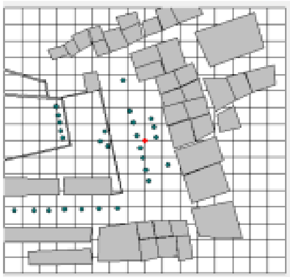
- Comparison of different scenarios and their efficiency in attaining thermal comfort.
- Study of how changes in the urban canopy affect microclimatic conditions compared to changes at the roof level.

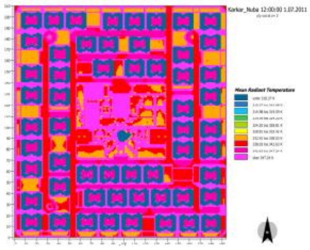
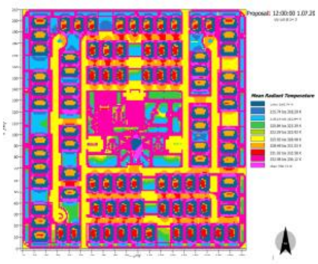
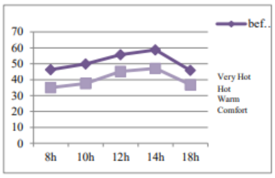
By addressing these aspects, the study aims to provide a robust framework of strategies for designing urban environments that not only improve thermal comfort but also contribute to sustainable urban development in the face of climate change.

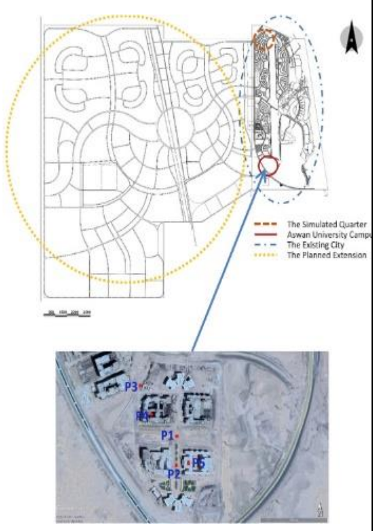
7 Results analyzing previous studies to design urban tissues that adapt to changing climates:

This study analyzes six previous studies that have identified various urban tissue design methods to mitigate and adapt to climate change. By presenting the details of these studies, we can better understand the advantages and disadvantages of each approach.

Name of study	**1- Urban form design that adapts to climate change an analysis of a Nubia case. [31]**	**2- Study on Enhancing Outdoor Thermal Comfort in the Open Public Space of Ouargla, Algeria. [32]**	**3- Developing and optimizing a comfort model for urban design (UDCM) based on passive solar principles at sites with mid-latitude. [33]**
Climate zone	Hot arid climate zone	Hot arid climate zone	Hot arid climate zone
Location	Aswan Egypt 	Ouargla, Algeria 	Egypt 
The project aim	This study examines the microclimatic thermal behavior of Egypt's driest climate conditions to develop	The study aims to analyze the influence of urban vegetation and shading on microclimate and thermal	The study aims to generate local climate conditions that can be used to expect neighborhood land uses

	insights for urban form design. The goal is to assess the effects of various strategies to enhance thermal comfort and sustainability in arid environments.	comfort in an open public area within a hot desert city.	based on pedestrian comfort.
Mitigation and adaptation strategies	urban geometries	urban geometries and greenery	vegetation
Case study application	The study investigates two urban design alternatives: one alters fabric orientation and disperses housing units, while the other increases density with a second floor. The first alternative emphasizes fabric orientation and decentralization, while the second focuses on density and compactness. Both aim to enhance thermal performance compared to the base case.  	Assessing the effects of greenery and shade structures, the research seeks to provide insights into improving thermal comfort and sustainability in arid urban environments. The study's base case is the Martyrs Plaza, situated in the southwest of the traditional quarter.   	The study comprises two base cases with different morphologies: New Cairo Suburban and Misr Al-Gadida. These areas represent distinct urban forms within Cairo.   The selected urban sites pattern of New Cairo Suburban and Misr Al-Gadida.
Study Tools	the Urban Design Comfort Model (UDCM) in MATLAB Grasshopper	Ray Man simulation software.	Envi-met software.

Results	Proposal 1 and Proposal 2 showed improved thermal comfort compared to the base case, especially from 11:00 am to 2:00 pm, with lower peak radiant temperatures. The base case recorded 71.1°C at 1:00 pm, while Proposal 1 and Proposal 2 were 65.6°C and 64.9°C, respectively. Enhancing vegetation or increasing the building-street aspect ratio can further improve shading and reduce Sky View Factor (SVF).  	Vegetation significantly reduces the Sky View Factor (SVF) to 0.117, thereby lowering radiation penetration and mean radiant temperature (Tmrt). With vegetation, Tmrt drops to 35.7°C at 8:00 am and 43.5°C at noon, while global radiation levels fall to 322 W/m² at 8:00 am and 587 W/m² at 2:00 pm. Comfort indices, including PMV, PET, and SET, are also notably improved. The maximum PMV, PET, and SET are reduced to 4.8, 47.1°C, and 41.2°C, respectively, compared to higher values in the non-vegetated scenario. 	The Physiological Equivalent Temperature (PET) at peak time dramatically decreased from the initial ENVI-met simulation result of 42.3°C for both sites. With the addition of extra foliage, the PET first decreased to 38.7°C and then further dropped to 36.8°C, demonstrating the substantial cooling effect of increased vegetation.
Name of study	**4- Using the ENVI-Met model, this study investigates the mitigation strategies of the urban heat island over the Greater Cairo Metropolitan Area in Egypt. [34]**	**5- The influence of urban morphology on the thermal comfort experienced outside in hot desert regions throughout the daytime.[35]**	**6- Examining the impact of street direction on outdoor thermal comfort in urban environments using simulation tools.[36]**
Climate zone	Hot arid climate zone	Hot arid climate zone	Hot humid climate
Location	Cairo, Egypt 	New Aswan, Egypt 	Jeddah, Saudi Arabia 

The project aim	The study intends to investigate the viability of three greening options (façade greening, roof greening, and urban parks) in UHI reduction.	The study aims to critique the current planning methods for new cities in Upper Egypt concerning outdoor thermal comfort and to propose practical planning guidelines to enhance pedestrian-level thermal conditions in future expansions.	The primary objective of this study is to investigate the urban configuration characteristics that influence the thermal outdoor comfort of individuals in Jeddah city, which serves as a representative of hot and humid climate zones.
Mitigation and adaptation strategies	Façade greening, roof greening, and urban parks	Geometric configurations	Urban configuration and street orientation
Case study application	The study area, located in the Greater Cairo Metropolitan Area, spans 420m by 330m and features diverse urban forms like Abu Qatada and Bein Es-Sarayat quarters. It includes 210 buildings of varying heights ranging from 3 to 30m and 94 trees and greenery. The arrangement of streets and buildings creates canyon shapes and orientations in relation to dominant wind patterns, making studying the dynamics of the microclimate more complex. The area's diverse urban characteristics make it an ideal location for research. 	The study simulates the microclimate of four quarters from GCR and one quarter from New Aswan using a calibrated microscale atmospheric model, analyzing their summer conditions in July 2018, revealing the highest pedestrian level Physiological Equivalent Temperature (PET). 	This study aims to investigate the specific factors related to street orientation that have the potential to improve human thermal comfort in outdoor environments. Advanced simulation techniques have been utilized to achieve the primary objective of the research. 

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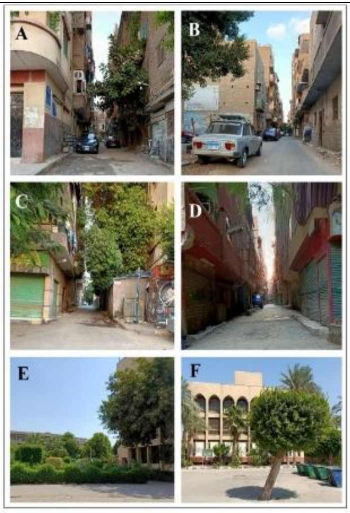
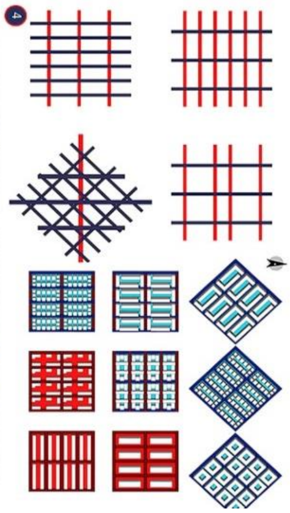
<td>
Photographs of urban components in the study area.</td>
<td>
The selected urban site and its pattern.</td>
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The selected urban sites and their orientations.</td>
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<td>Study Tools</td>
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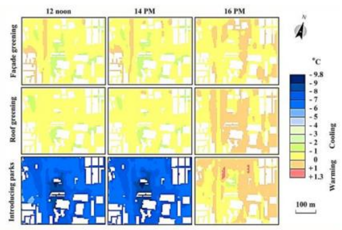
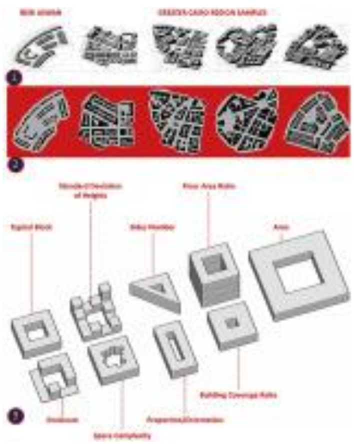
<td>Results</td>
<td>The study suggests that implementing façade and roof greening could reduce air temperature by up to 0.5°C, while hypothetical pocket parks might provide significant cooling effects of up to 7°C until 3:00 PM. However, these parks may develop heat island properties later in the day. These findings offer insights for optimizing urban green spaces to enhance cooling potential and improve microclimates.

Modeled cooling effect of three greening techniques at 1.50 m above ground.</td>
<td>Urban geometry variations can affect average PET by up to 9°C at individual streets, with shade being the most important parameter. Urban form variables explain over half of the variation, with enclosure extent, Floor Area Ratio, aspect ratio, and orientation being most impactful at the street scale.
</td>
<td>The study assesses four cases based on air temperature, wind speed, relative humidity, and PMV. Comfort values range from 20°C to 27°C, with relative humidity from 25% to 60%. Wind speed ranges from 2.5 to 5.00 m/s, and PMV comfortable values are (0). Summer temperatures exceed comfortable levels, while wind speed reaches maximum at F-2. Thermal comfort indicators reach highest discomfort levels, with F-2 being the best location.</td>
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8 discussion

The study evaluates thermal comfort conditions in six neighborhoods with varying urban tissues, focusing on climate change mitigation and adaptation. The aim is to design urban environments prioritizing outdoor thermal comfort, improving residents' quality of life.

Using a comparative analysis of urban design by simulation programs in Egypt's hot arid climate aimed to reaching strategies for enhancing thermal comfort and reducing urban temperatures through climate change mitigation and adaptation measures. Factors such as vegetation density, permeable pavements, roof and wall reflectivity, and urban layout design were assessed across different metropolitan areas.

Urban vegetation and pavements can significantly influence microclimatic conditions, as strategies that lower air temperatures enhancing cooling efficiency. Expanding vegetation and introducing permeable pavements can achieve a cooling effect of about 2.7 degrees in air temperature. Numerical models show that increasing vegetation, expanding pavements, and improving roof reflectivity can reduce daytime and nighttime air temperatures during hot summer seasons. Enhancing shade and reducing radiative budget improves outdoor thermal comfort more than increasing evaporation.

9 Conclusion:

Urban strategies for climate adaptation are transforming the traditional view of urban tissue, enabling cities to implement policy reforms without additional funding or constraints. This approach integrates climate adaptation into urban design, fostering local resilience and resilience.

Urban tissue design plays a crucial role in mitigating climate change and enhancing thermal comfort. By incorporating green mitigation strategies and incorporating green spaces, urban planners and architects can create improved environments that are more sustainable. The study highlights the significant impact of urban design on thermal comfort and the importance of incorporating greenery in urban design.

The analysis emphasizes the crucial importance of urban green areas in improving thermal comfort and mitigating excessive temperatures, especially during the hours of highest heat between 11:00 am and 2:00 pm. The main discoveries consist of:

- **Temperature Improvement:** By incorporating vegetation into building designs, such as by adding greenery to facades and roofs, there is a clear decrease in air temperature of up to 0.5°C. This may greatly improve thermal comfort by decreasing maximum PMV, PET, and SET values compared to situations without vegetation.
- **Cooling Effects:** Potential pocket parks have significant cooling benefits, possibly reducing temperatures by up to 7°C, indicating their efficacy in urban design.
- **Impact of Urban Geometry:** Differences in the layout of urban areas have a substantial impact on the average PET (Physiological Equivalent Temperature) readings, with a recorded variation of up to 9°C across various streets. The elements that have the greatest influence are the supply of shade, the amount of enclosure, the Floor Area Ratio, the aspect ratio, and the direction of the street.
- **Shade as a Key Factor:** The analysis highlights the significance of shade as the primary factor in guaranteeing thermal comfort, underscoring the need of carefully incorporating flora in urban environments.
- **Comprehensive Assessment**: The research emphasizes the need to tackle summer temperature spikes that are beyond acceptable levels by analyzing many factors like air temperature, wind speed, and humidity.

Ultimately, the incorporation of urban green spaces and the consideration of urban form elements are crucial strategies for reducing the impact of heat and improving general comfort in urban areas, so promoting healthier and more sustainable cities.

Urban tissue design strategies in Egypt are being explored to mitigate climate change by incorporating vegetation density and urban layout design into thermal comfort. This study emphasizes the need for resilient, sustainable urban settings, highlighting the importance of incorporating climate adaptation measures into infrastructure policies to ensure a more sustainable future.

By conducting a comprehensive comparative study of different cases, we find that every component of urban infrastructure utilizes unique approaches to tackle climate change and strengthen resilience against its effects. Therefore, these techniques have been methodically gathered to create a complete strategy that includes a broad spectrum of adaptive actions. This strategy is intended to be executed, enabling the evaluation of its efficacy in an actual environment. This study serves as a first step towards doing more application studies, with a specific focus in Egypt.

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