بسم الله الرحمن الرحيم

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تم رفع هذه الرسالة بواسطة / حسام الدين محمد مغربي

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى مسئولية عن محتوى هذه الرسالة.

ملاحظات : لا يوجد

Ain Shams University
Faculty of Engineering
Urban Planning

Adaptive Landscape Design for Urban Microclimate

A Thesis submitted in partial fulfillment of the requirements of the degree of

Doctor of Philosophy in Architectural Engineering

(Urban Planning)

By

Wesam Mansour El-Bardisy
Master of Science in Architectural Engineering
Faculty of Engineering, Ain Shams University, 2015

Supervised by

Prof. Mohamed Abdel-Karim Salheen
Professor of Integrated Planning & Design
Ain Shams University

Prof. Mohammed Fahmy Abdel-Aleem
Professor of Sustainable Architecture & Urban Environment
Military Technical College

Cairo - (2022)

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Statement

This thesis is submitted as a partial fulfilment of Doctor of Philosophy in Architectural Engineering Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Date:22 July 2022

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Thesis Summary

Climate Change has been a global reality, cities are particularly vulnerable to its impacts. The emergence of industrialization and urbanization are the root cause for this phenomenon: the release of Green House Gas emissions; and Urban Heat Island (UHI). It negatively affects the quality of urban environments and threatens the human health on top. Cascading Climate change (CC) impacts and implications from a global to local level; Egypt is a typical developing country vulnerable to CC. Numerous threats to its economic, social, and environmental sustainability including energy, water, and food security.

Egypt's share to GHG emissions does not exceed the 0.7 % from the global quota share. Moreover, Egypt lies in the hot desert zone which is prone to higher heat waves that can exceed 50°C due to its climate nature, stated by couple of research. Yet, since 2019, Egypt extensively is taking stricter and major actions towards mitigating and adapting towards climate issues i.e., "Egypt Climate Strategy 2050" and the updating of "Egypt's 2030 vision" which inline with the Sustainable Developed Goals SDGs initiated by the United Nations.

We examined diverse relevant literature for Cairo's climate situation and concluded the following: Cairo is affected by high Land Surface Temperature LST which results in an increased UHI , particularly in the eastern region of the city; additionally, in urbanized areas higher temperature rates 2 to 4 degrees Celsius in day and nighttime ; low to nearly very limited presence of vegetation which acts as an urban cooler; High thermal discomfort which hinders human activities in comparison with rural / less urbanized areas. This discourage using the outdoor urban areas and creates a surpass cooling demand for indoors that in turn fosters UHI and CC – the

vicious cycle. The absence of climate design and application in the field is one of the main factors towards these findings.

For this we adapted the approach of utilizing green infrastructure as a potential tool for mitigating urban climates. Vegetation improves microclimate, adapts to CC, and reduces the energy consumption through radiation intercept and evapotranspiration process among other landscape elements. This, also, has a significant impact on achieving human thermal comfort.

we aimed to establish decision-making framework for regulating the microclimate and enhance human thermal comfort in the outdoor usable spaces through landscape design. Also, we questioned what the microclimate vegetative strategies landscape Architects and urban designer s can offer to enhance the extreme climate conditions in the arid regions.

As an initial step, the research, based on the theoretical background, has developed a superior comparative analysis between urban trees, vertical greening systems, and green roofs in terms of suitability, applicability, performance, and implementation. Also, established guideline for tree possible arrangement and spacing. As a second step we utilized the suitable tools for climate maps execution and context evaluation. Consequently, we developed a methodological framework to select climate vulnerable areas on the local climate and microclimate scale for microclimate moderation and cooling purpose using remote sensing techniques and numerical modeling and simulation tool.

This framework is tested on Cairo's east region reaching to the street level at el-Nozha neighborhood using several models and simulation techniques; Geographic information systems, ENVI-met microclimate simulation as a primary tool, and context-

based criteria. In addition to the secondary tools which provides the required inputs for GIS and ENVI-met.

By this, the research contributes towards establishing a decision-making framework for mitigating UHI vulnerable areas using vegetation in Cairo which strongly affects: the human thermal comfort, microclimate, and the indoor energy consumption. This also, contributes towards translating the knowledge and work generated through sophisticated tools to a simply practical guide for enhancing the microclimate for landscape Architects, urban designers, and related fields.

It not only gives the basic knowledge but also, (1) quantifying the cooling effect of trees and how it impacts the human thermal comfort level; (2) understanding the microclimate each tree type creates ;(3) designing and allocating trees at wide streets in terms of the type or arrangement and spatial location; (4) priority strategies for vegetation to solar irradiance reduction are nearly absent and not considered. Thus, this work highlights these considerations in a simple guidance form to be a unique addition in the process of landscape design and planning.

Key words:

Climate change, Urban Heat Island, Mitigation, vegetation, Microclimate, GIS, ENVI-met, numerical simulation, Thermal comfort, Trees, Green roofs, Vertical greening system., practice, research, Cairo, Egypt, Hot spot, Thermal comfort, PET