

**CLIMATE-SENSITIVE URBAN PUBLIC SPACE:
A SUSTAINABLE APPROACH TO URBAN HEAT
ISLAND MITIGATION IN COLOMBO, SRI LANKA**

Narein Gerald Rajintha Perera

(03/9908)



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Degree of Doctor of Philosophy

Department of Architecture

University of Moratuwa
Sri Lanka

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Thesis submitted in partial fulfilment of the requirements for the degree
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Declaration

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other university or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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.....
Signature of Supervisor: Prof. P K S Mahanama
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dedicated to;
my children; ananya, vinaya, dhruv
my wife; pendrine
and to my parents

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Abstract

Manipulating the urban fabric is fundamental to mitigate and adapt to the warming trend in the growing high-density tropical cities. However, excessive data needs, weak analytical methods and the un-coordinated planning regimes pose barriers to achieving this aim.

The main aim of the research is to bridge the gap in urban design-climate links, being translated into guidelines for real-world applicability in a background climate affected by global warming. The study is limited to the warm humid tropical climate of Colombo, Sri Lanka, as the experimental context for the research.


The main research questions are related to; the microclimatic background condition under current and future warming scenario; sensitivity of the key urban morphology variables that will define and drive the decision making process; and the planning and policy implications that link climate and urban design. The study employs the Local Climate Zone (LCZ) system as a method of contextual analysis, together with LCZ-based morphology simulations (ENVI-met), utilising Mean Radiant Temperature (MRT) as the key dependent variable. Statistical analyses (SPSS) of the results test the applicability and sensitivity of urban morphological variables to help mitigate / adapt to local and global warming.

The findings indicate that the Sky View Factor is the most influential urban indicator of local climate. In general, night-time shows better correlation with MRT. The nature of the Pervious Surface Cover has little or no effect on reducing MRT. And, the correlation of variables with MRT is stronger in a climatic background affected by global warming.

The work contributes a 'conceptual framework' for the deeper understanding of the effect of building morphology on local level warming in the tropics. Policies that give effect to these findings are presented in a manner that requires minimal data input. Protocols for mapping of LCZs and relative warming effects, and sensitivity analysis of key design parameters for the mitigation of UHI in the tropics are presented. The socio-economic and planning practice implications of a LCZ-based planning approach are explored.

Keywords: ENVI-met, Global warming, Local Climate Zones, MRT, Urban Heat Island, Warm Humid Tropics

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List of Abbreviations

AVA	Air Ventilation Assessment
BSF	Building Surface Fraction
CASBEE	Comprehensive Assessment System For Built Environment Efficiency
CMC	Colombo Municipal Council
CMRSP	Colombo Metropolitan Region Structure Plan
DGP	Development Guide Plans
FAR	Floor Area Ratio
GIS	Geographic Information System
GSF	Green Surface Fraction
HRE	Height of Roughness Elements
IPCC	Intergovernmental Panel on Climate Change
ISF	Impervious Surface Fraction
LCZ	Local Climatic Zones
LQ	Location Quotient
MRT	Mean Radiant Temperature
PET	Physiological Equivalent Temperature
PMV	Predicted Mean Vote
PSF	Pervious Surface Fraction
q	Specific Humidity
q.rel	Relative Humidity
RMSE	Root Mean Square Error
SHIM	Surface Heat Island Model
SPSS	Statistical Package for the Social Sciences
SVF	Sky View Factor
t	Temperature
UBL	Urban Boundary Layer
UCL	Urban Canopy Layer
UCMap	Urban Climate Map
UDA	Urban Development Authority
UHI	Urban Heat Island
u, v, w	Wind Velocity
wDir	Wind Direction
WMO	World Meteorological Organisation
wSpeed	Wind Speed
WUDAPT	World Urban Database And Access Portal Tools

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