



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

**URBANISATION AND THERMAL COMFORT CHANGE;
THE CASE OF COLOMBO METROPOLITAN REGION.**



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

**A dissertation submitted to the University of Moratuwa
As a Partial Fulfilment of the requirements for the Degree of
Master of Science in Architecture.**

පරික්ෂණ
විද්‍යා විද්‍යාලය, ශ්‍රී ලංකාව
මොරටුව

074084



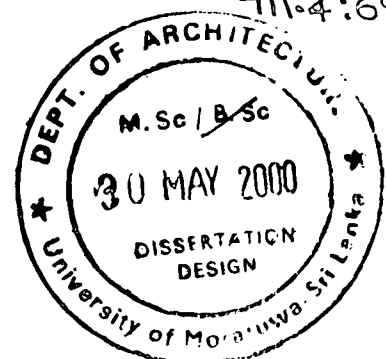
University of Moratuwa

D. R. Sirimanna
Department of Architecture
University of Moratuwa.
May 2000

74084

72 "00"

711.4:697.13



ABSTRACT

It appears that urban process (Urbanisation) itself has great contribution to its own microclimate. In urban design /planning point of view urbanisation must then be essential to recognise and deal as physical urban element change (built areas, tree covered areas, green/ grass areas, streets and paved areas, and bare lands) to identify its effect on its microclimate while that change occurred in a particular area, then being calculated as thermal comfort change.

Since the research study is framed on Time Rate Change Method; series of aerial photographs from the Survey Department at different intervals, over respective time period of 50 years, provide information regarding urban physical element change. Day and night temperature humidity values taken from the meteorological department provide basis to calculate monthly day and night thermal comfort indices a particular area.



University of Moratuwa, Sri Lanka
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

The study concentrated on three segments of Colombo Metropolitan Region, namely Colombo City, Katunayake, and Rathmalana. Each areas studied include at 0.5-Km radius circle around the meteorological stations. Data was collected for the period of 1956-1999.

The study high lights the urban physical element changes occurred due to such process during the studied period contributed to thermal comfort variation. Finally this research point out some of the very important relationships between urban physical change and thermal comfort change. The three areas have been ranked, according to thermal comfort change in order to identify the future urbanisation and thermal comfort scenarios of that particular areas.

ACKNOWLEDGEMENTS.

I wish to express my heartfelt gratitude to the following persons , whose assistance to me during the study is greatly appreciated .

Professor N.Silva , Head of the department, Department of Architecture , University of Moratuwa for valuable guidance.

Dr. R. Emmanuel my dissertation tutor, for the unstinted support and inspiration extended to me, in importing his experiences on the subject, and guiding me. I wish to extend my deep appreciation and gratitude to him for directing me, his patience and precious time expended in this aspect.

Dr. L.S.R. Perera, Archt. Chadrsekara, senior lecture department of Architecture and planner , K.D. fernando , senior lecture , department of town country planning University of Moratuwa for their initial guidance and invaluable comments.

I must express my heartfelt thanks to the staff members of the Survey Department and Meteorological Department for their kindness and help in the collection of data in this dissertation.

Nuwan for photographs

Thilini Daluwatta, Thilini Alahakoon, Chandima Bandaranayike, Chamila perera, Samanthika , Salmali , Chamika, Sewwandi accompany and Gayan for being my source of strength and encouragement in numerous ways.

My mother, brother and sister for all their support , tolerances and above all , for the one extended to me at all difficult time.

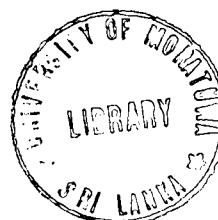


TABLE OF CONTENTS

Abstract	(i)
Acknowledgement	(ii)
List of Figures	(iii)
List of Tables	(iv)

CHAPTER ONE

1.1 Introduction	1
-------------------------	----------

CHAPTER TWO

Literature review

PART ONE

Literature review of urbanization.

2.1 Urbanization	6
2.1.1. Urbanization in Sri Lankan Context	8
2.1.2 Description of Data Collection areas	12
2.1.2(a) Colombo city station area	13
2.1.2(b) Katunayake area	22
2.1.2(c) Rathmalana area	29



University of Moratuwa, Sri Lanka
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

PART TWO

Literature review of climate studies

2.2 An introduction to urban climate studies	37
2.2.1 Characteristic of Sri Lanka Climate	39
2.2.1(a) Temperature scenarios for Sri Lanka	40
2.2.1(b) Rainfall scenarios for Sri Lanka	42

PART THREE

2.3 Urban heat islands	45
2.3.1 Characteristics of urban heat islands in Equatorial areas	46
2.3.2 Causes of urban heat – islands	47
2.3.3 Thermal comfort in urban out doors in the equatorial tropics	49
2.3.4 Thermal comfort studies in Sri Lankan context	50
2.3.5 Mitigation of urban heat islands	52



CHAPTER THREE

Methodology

3.1	Methods of measuring Urban Heat Island Effect	54
3.1.1.	Time rate change method (T.C.M)	55
3.2	Method of analysing urbanization	56
3.2.1	Aerial photographs as a method of analysing urban changes	57
3.2.2.	Interpretation of aerial photographs	57
3.2.3	Example analysis of urban changes in an urban area	60
3.3	Method of analysing the climate data	65
3.3.1	Method of measuring and calculating the temperature data	65
3.3.2	Method of measuring and calculating the data relative humidity	65
3.3.3.	The temperature humidity index and discomfort index	66
3.3.4.	Example : Calculation of T.H.I. Value	67

CHAPTER FOUR

Results and Analysis

PART ONE

4.1	Urban physical changes and thermal comfort changes in Colombo City station area	70
4.1.1.	Urban physical change	73
4.1.2	Climate & Thermal comfort changes	77

PART TWO

4.2.	Urban physical changes and thermal comfort changes in Katunayake station area	79
4.2.1	Urban physical change	82
4.2.2	Climate and Thermal comfort changes	83

PART THREE

4.3.	Urban physical changes and thermal comfort changes in Rathmalana station area	88
4.3.1	Urban physical change	91
4.3.2.	Climate and thermal comfort change	92

CHAPTER FIVE

Summary of findings

5.1	Summary of findings	97
5.2	Summary of findings and their relationships	104
		v.

CHAPTER SIX

Conclusion

6.1	Conclusion	109
6.2	Limitation	113
6.3	Future Directions	115

References	116
------------	-----

Appendix	-	Aerial Photographs
	-	Climate data



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk



LIST OF FIGURES

1.	Selected physical elements for this study	7
2.	The ancient development pattern of Anuradhapura city	8
3.	A reduced fascimility of the Cypriano Sanchez map of Ceylon 1560-1505 A.C.	10
4.	The Ancient development pattern of Colombo city area	11
5.	Colombo Katunayake ,Rathmalana areas in relation to Colombo Metropolitan region	12
6.	Descriptive map of study area (Colombo city station)	13
7.	Arial view of Colombo city station area in 1999	14
8.	Plan of Colombo in 17800. This map identifies Fort & Pettah areas ,and areas of Cinnamon Plantation perhaps which latter became the Cinnamon Gardens	15
9.	The lake and Slave Island from glacis	16
10.	Town Hall	16
11.	Independence Commemoration hall	17
12.	Bandaranaike Memorial International Conference Hall	18
13.	In Colombo City Station area	18
14.	Green areas in Baudhdhaloka Mawatha	19
15.	Map of Cinnamon Gardens in 1895 shows it's skeletal frame work	20
16.	View along Baudhdhaloka Mawatha,showing its tree lined character	16
17.	Descriptive map of study area	22
18.	Arial view of Katunayake area in 1999	23
19.	Column Constructed by Dutch	24
20.	Dutch Canal	24
21.	Physical Changes occurred in Katunayake	25
22.	Land use pattern of the study area	26
23.	Katunayake Free trade zone (lay out)	26
24.	Still remaining rural settings of Katunayake	27
25.	Road net work in Katunayake	27
26.	Road and its character in Katunayake	28
27.	Descriptive map of study area	29
28.	Aerial view of Katunayake area in 1999	30
29.	Factory buildings in Rathmalana	33
30.	"Wawe" by the side of Kandhawala road	34
31.	Railway yard at Rathmalana	
32.	Railway yard at Rathmalana	
33.	Vertical sterio photograph	56
34.	Oblique photograph	57
35.	The variation in valve between the slopes of hip roof	58
36.	Visible light and its effect on leaves	59
37.	Visible light and its effect on water	59
38.	Aerial view of 0.5 km radius from meteorological station	60
39.	Illustrative presentation of Colombo city station area in 1999 Built area	61

40	Illustrative presentation of Colombo city station area in 1999 Tree covered area	62
41	Illustrative presentation of Colombo city station area in 1999 Road & paved	63
	Areas shown separately	
42.	Areas shown separately of Colombo city station area in 1999 Ground /Grass areas	64
43.	Aerial view of Colombo city station	70
44.	Urban land use changes in the last 50 years –Colombo	72
45.	Day and night T.H.L values for Colombo	76
46.	Aerial view of Katunayake	79
47	Urban land use changes in the last 50 years - Katunayake	81
48	Day and Night T.H.L values for Katunayake	87
49.	Aerial view of Rathmalana area	88
50.	Urban land use changes in the last 50 years – Rathmalana	90
51	Day and Night T.H.L values for Rathmalana	95
52.	Day time T.H.L values in Colombo metropolitan region	100
53.	Night time	102



LIST OF TABLES

1.	Global climate changes	38
2.	Highest Temperature Scenarios for Sri Lanka C	41
4.	Rainfall Scenarios for Sri Lanka , SIRO 92, High	42
5.	Existing /Rainfall variability and projection for year 2070	43
6.	Effect of Urbanisation on Climatic Parameters	45
7.	Changing trends in Urban physical elements during last 50 years in Colombo (Area in Sq.m)	71
8.	Changing trends in Urban physical elements during last 50 years in Colombo (Areas a percentage)	71
9.	Day and Night T.H.L values for Colombo	75
10.	Changing trends in Urban physical elements during last 50 years in Katunayake (Area in Sq.m.)	80
11.	Changing trends in Urban physical elements during last 50 years in Katunayake (Area in Percentage.)	80
12.	Day and Night T.H.L values for Katunayake	86
13.	Changing trends in Urban physical elements during last 50 years in Rathmalana (Area in Sq.m.)	91
14.	Changing trends in Urban physical elements during last 50 years in Rathmalana (Area in percentage)	91
15.	Day and Night T.H.J values for Rathmalana	94
16.	Day time T.H.L variation in Colombo meteorological station During last 50 years	99
17.	Night time T.H.L variation in Colombo meteorological station During last 50 years	101
17.	Research Climate Oriented results in Colombo Metro Region (Night time)	103
18.	Research Climate Oriented Results in Colombo Metro Region (Day -Time)	103
19.	Available Climate data	113
20.	Available aerial Photographs	114