

UNIVERSITI TEKNOLOGI MARA

MEASURING THE ABILITY OF
HERITAGE TREE IN MITIGATING
URBAN HEAT ISLAND (UHI)
THROUGH GIS AND REMOTE
SENSING INTEGRATION IN
TAIPING, PERAK

NOR SUHAIDA BINTIYUSOF

Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science
(Green Architecture)

Faculty of Architecture, Planning and Surveying

February 2020

ABSTRACT

Every tree species provides different cooling effects depending on their tree characteristics. Evergreen species such as heritage tree are significant in reducing the surface temperature. In particular, heritage trees do have environmental implications which provide a lot of benefits for the environment and human health. However, the cooling effects from tree species are differ by areas they are planted. The different albedo value land cover features materials have influenced the performance of tree species in giving the cooling effects to the environment. Therefore, the aim of the study is to determine the ability of heritage trees surface temperature with land cover features in mitigating urban heat island (UHI) in Taiping Old Town. The research investigated the internal and external factors of heritage trees in reducing the Land Surface Temperature (LST) in study area. The data was utilized from satellite imagery of Landsat 8 OLI that were obtained from USGS websjite. These data were processed using ERDAS IMAGINE 2014 software using graphical model function technique to generate the LST distribution of study area. Field observation was also conducted to measure the heritage trees characteristics based on the vegetation parameter of cooling effect. Then, the data was processed using the GIS tools for further data analysis. These results later correlated to measure the relationship between heritage trees and LST distribution at study area. The result indicates that the contribution of heritage trees is dominant in the vegetation parameter of cooling effect in which it could only contribute 24.8% of cooling effect to the surrounding area. This is because the cooling effects from heritage trees were influenced by external related factors. The albedo values of land cover features for both man-made and natural features showed the shocking result by showing linear positive relationship with the R^2 values equals to 0.708. This result was contradicted from previous research that showed higher albedo values resulted to lower surface temperature. However, the findings of the research revealed that the lower albedo values resulted to lower surface temperature. This is because the higher frequency of heritage trees planted at the hard surface caused higher ability to reduce the LST in urban areas. In conclusion, the finding of this research could significantly contribute to the landscape practise and design, toward mitigate UHI effects.

ACKNOWLEDGEMENT

Alhamdulillah, all praises be to Allah (S.W.T) for providing me the strength, good health and patience in accomplishment of this study. With His Grace and Blessing, I have been received the remarkable knowledge and inspiration through a challenging throughout this study.

I would like to offer my greatest gratitude to my main supervisor, Dr Nur Huzeima Mohd Hussain for supporting me throughout my thesis writing with great guidance and knowledge. Thank you for your patience in guiding me, giving constructive advices when I was lost and being an understanding supervisor during my hard time. The special appreciation also dedicated to my co-supervisor, Dr Noradila Rush for guiding and providing me the knowledge on the thesis technical and methodology. Your kind guidance and tolerance never fail to inspire me. I am very grateful to have both of you as my supervisors who give the encouragement and effort. Without both of you, this thesis would have not been completed and written.

My great deep gratefulness to my husband, Ahmad Syakir Fahimi for his sacrifices, love, support, patience and understanding during this study. Thank you for helping me and taking care of me since I was pregnant during data collection and giving the motivation during my tiredness along the journey to complete this study. Also, to my beloved daughter, Nusaibah Safiyya, your smile and cry were my best remedies throughout this journey. My great sincere thanks to my beloved father, mother, in laws; Yusof Embong, Juary Said, Mohamed Salleh and Wan Rohani Wan Ismail, siblings and families for giving courage and endless prayers for me through my ups and downs.

Last but not least, many thanks to Green Architecture Master students from cohort 5 UiTM Perak for the support and guidance. Not forgetting to Department of Surveying Science and Geomatics UiTM Perak that was willing to borrow me the instruments for data collections. The appreciation also goes to U.S Geological Survey Department (USGS), Malaysian Meteorological Department (MMD) and Taiping Municipal Council for their unlimited help and provision of data and official documents. I would like to convey my deepest thanks to *Majlis Agama Islam dan Adat Melayu Terengganu* (MAIDAM) for "zakat" financial support, so I can finance my study fees.

Again, I pray that someday, Allah S.W.T. will repay the care all of you have provided me.

TABLE OF CONTENTS

	Page
CONFIRMATION BY PANEL OF EXAMINERS	ii
AUTHOR'S DECLARATION	iii
ABSTRACT	iv
ACKNOWLEDGEMENT	v
TABLE OF CONTENTS	vi
LIST OF TABLES	x
LIST OF FIGURES	xii
LIST OF SYMBOLS	xvii
LIST OF ABBREVIATIONS	xviii
CHAPTER ONE: INTRODUCTION	1
1.1 Introduction	1
1.2 Problem Statement	3
1.3 Aim and Objectives	6
1.4 Research Questions	6
1.5 Scope and Limitation	6
1.6 Significance of the study	7
1.7 Chapter Overview	8
1.8 Summary	9
CHAPTER TWO: LITERATURE REVIEW	10
2.1 Introduction	10
2.2 Heritage Tree: Definition	10
2.2.1 The benefits and values of heritage trees.	12
2.2.2 Legislation and Guideline on Heritage Trees	15
2.2.2 Heritage tree: Internal and External Factors	17
2.3 Urban Heat Island (UHI): Definition	18
2.3.1 Formation of UHI Phenomenon	20

2.3.2	Land Surface Temperature (LST) for UHI Intensity	22
2.3.3	UHI Studies	24
2.3.3.1	<i>Non-tropical Climate UHI Studies</i>	25
2.3.3.2	<i>Tropical Climate UHI Studies</i>	28
2.3.4	UHI Studies in Malaysia	31
2.3.5	Effect of UHI	35
2.3.5.1	<i>Human Thermal Comfort</i>	35
2.3.5.2	<i>Energy Consumption</i>	36
2.3.5.3	<i>Air and Water Quality</i>	37
2.3.5.4	<i>Human health</i>	38
2.4	Influences of land cover surface in UHI mitigation strategies	39
2.4.1	Role of Vegetation in UHI Mitigation Strategies	40
2.4.1.1	<i>Vegetation characteristics for optimal cooling effect</i>	43
2.4.1.2	<i>Heritage Tree dominant in vegetation element for cooling effect</i>	46
2.4.1.3	<i>Individual and cluster trees in reducing urban surface temperature</i>	47
2.4.2	Thermal Reflectivity (Albedo) and Urban Ground Surface	49
2.5	Application of GIS and Remote Sensing in UHI studies	53
2.5.1	Geographic Information System (GIS)	55
2.5.1.1	<i>Spatial data</i>	57
2.5.1.2	<i>Attribute data</i>	64
2.5.2	Remote Sensing	65
2.5.2.1	<i>Landsat8 OLI</i>	67
2.6	Summary	69
CHAPTER THREE: METHODOLOGY		73
3.1	Introduction	73
3.2	Research Methodology Framework	73
3.3	Background of Study Area	77
3.4	Landsat 8 OLI pre-processing	79
3.4.1	Layer Stack	81
3.4.2	Radiometric Correction	81
3.4.3	Subset image	82