



A STUDY ON THE CORRELATION BETWEEN
URBAN TEMPERATURE AND GREEN SPACES
USING GIS AND REMOTE SENSING TECHNIQUES:
CASE STUDY OF KUALA LUMPUR AND BATU
PAHAT

BY

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A dissertation submitted in partial fulfillment of the
requirements for the degree of Master of Urban and
Regional Planning

Kulliyyah of Architecture and Environmental Design
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APRIL 2013

ABSTRACT

In recent years, rapid urbanization had transformed the spatial pattern of urban land uses worldwide that had resulted in the losses of urban green spaces apart from continuously altering the urban ecosystems. Along with it, the rising of temperatures in urban areas or what is commonly known as the “urban heat island effect” has become one of the most serious urban problems. This is especially so due to the impact it has on the urban microclimate, air quality, and public health. Presently, the analysis of the satellite images using geographical information system (GIS) is often used to determine the impact of the land coverage (including urban green spaces) that has resulted in the changes in the surface temperature. The aim of this research is to study the correlation between the urban temperature and the urban green spaces. This research used processing software, ENVI and ArcGIS for analyzing Landsat TM images to study the correlation. ENVI is used for processing the satellite images and to classify the land cover, and ArcGIS is used to analyse the data and create maps for the study. The results showed that there is a strong correlation between the urban temperature and the urban green spaces and the temperature. The study shows that green coverage and urban heat island are inversely proportional, i.e. the greater the green coverage area, the lower is the intensity of heat island. The correlation also varies according to the urban hierarchy. This is due to the level of development and built-up area of the various urban centers. The integration of remote sensing and GIS was found to be effective in monitoring and analyzing the changes in land cover and to evaluate its effect on surface temperature. Some suggestions to solve the issues and to improve the urban environment are also proposed and discussed in this paper.

ملخص البحث

تسارعت في الفترة الأخيرة حالات بناء الهجرة من المناطق الريفية إلى المدن، تلك الظاهرة التي حولت صورة المناطق القروية حول العالم؛ الأمر الذي أدى إلى فقدان المساحات الخضراء كجزء من التغير المستمر للنظام الاقتصادي السياسي للمناطق الريفية . وارتفاع درجة الحرارة في المناطق المهاجر إليها، أو ما عرف باسم " تأثير الجزيرة القروية الحارة " التي أصبحت واحدة من أصعب المشاكل الجادة للمناطق التي يأوي إليها هؤلاء المهاجرين. هذا الأمر ناشيء عن : التأثير الميكروبي للمناخ , ونقاء الهواء، والصحة العامة . في العصر الحالي كثيراً ما يحكم تحليل صور الأقمار الصناعية مستخدماً معلومات النظام الجغرافي بتأثير تغطية الأرض (تشمل مناطق الفراغ الأخضر) كنتيجة لتغيير درجة الحرارة . هدف هذا البحث دراسة العلاقة المتبادلة بين درجة حرارة المناطق المهاجر إليها و المساحة الخضراء , اعتمد هذا على معالجة الكترونية لتحليل العلاقة التبادلية بواسطة ENVI الذي يستخدم في معالجة صور الأقمار الصناعية و تصنيف الأراضي المدروسة , و ArcGIS remote sensing لتحليل البيانات ورسم الخرائط للدراسة. النتائج أظهرت العلاقة المتبادلة بين درجة حرارة المناطق المهاجر إليها و المساحة الخضراء . الدراسة تظهر أن التغطية الخضراء و الجزيرة القروية الساخنة تتناسبان تناسباً عكسياً أي زيادة المساحة الخضراء ينقص ما يعرف بالجزيرة الساخنة الكبيرة . العلاقة المتبادلة تتغير صورها طبقاً للتسلسل الهرمي للمناطق القروية، هذا ناشيء عن درجة التقدم ومبني على الصور المختلفة للمناطق القروية , الدمج بين الاستشعار عن بعد و GIS وجد أنه أكثر فعالية في مراقبة و تحليل التغيير في الأرض المدروسة و تخمين تأثيرها على الواجهة الحرارية . بعض الاقتراحات لحل القضايا و تطوير البيئة القروية أيضاً تم عرضها ومناقشتها في هذه الورقة.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Urban and Regional Planning.

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DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

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ACKNOWLEDGEMENTS

In the name of Allah, the most Gracious, most Merciful. All praise be to Allah for His guidance and blessings, without which, I would not be able to complete this course successfully.

First and foremost I would like to thank my supervisor, Asst. Prof. Dr. Norzailawati Hj. Mohd Noor for her encouragement, patience, guidance and advice throughout this research. My sincere gratitude extends to the entire staff IIUM, specifically the staffs of the Department of Urban and Regional Planning for their support. May Allah bless you all.

I would also like to express my thanks and gratitude goes to the Malaysian Remote Sensing Agency, particularly Puan Zainul Izzah for all the help she had given in providing the information and data that were used throughout this research. Without her help, this research would not be able to be completed successfully.

My special appreciation goes to all my friends and colleagues who have directly or indirectly contributed to the completion of my studies especially Khin Cho Myint @ Zainab and Nur Nabila Ahmad Azam.

And finally, a special thanks to my parents for their guidance and helpful suggestions throughout my studies. Their strength and support had been a constant inspiration and had helped me keep my spirits up during difficult times.

I thank all of you for the support, kindness and care. May Allah bless you all.

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LIST OF ABBREVIATIONS

AATSR	Advanced Along-Track Scanning Radiometer
ARSM	Malaysian Remote Sensing Agency
AVHRR	Advanced Very High Resolution Radiometer
BP	Batu Pahat / Bandar Penggaram
DBKL	Kuala Lumpur Municipal Council
DN	Digital Number
ENVI	Environment for Visualizing Images
EPA	Environment Protection Agency
ETM+	Enhanced Thematic Mapper Plus
GCP	Ground Control Point
GIS	Geographical Information System
GLA	Greater London Authority
ICID	International Commission on Irrigation and Drainage
IDL	Interactive Data Language
JPBD	Department of Town and Country Planning
JUPEM	Department of Survey and Mapping Malaysia
KL	Kuala Lumpur
MS	Multi-Spectral
NDVI	Normalized Difference Vegetation Index
NIR	Near Infrared
ROI	Region Of Interest
RS	Remote Sensing
SPOT	Système Pour l'Observation de la Terre (System for Earth Observation)
TM	Thematic Mapper

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF STUDY

Urban green space is seen as an important contribution to a sustainable development of cities. It plays an important role in improving the liveability of our towns and cities. The quality and liveability of cities depend on the design, management and maintenance of the urban green space that offers visual representation of urban quality (Baycan-Levent and Nijkamp, 2004). In recent years, rapid urbanization has transformed the spatial pattern of urban land uses worldwide that has resulted in the losses of urban green spaces apart from continuously altering the urban ecosystems (Gairola and Noresah, 2010).

Furthermore, the provisions of the green spaces have always been overlooked. The existing green spaces are often abused and reclaimed to create space for buildings and road system. Less priority is given in providing ample open space for the urban dwellers. This is believed due to no concrete methodology that has been applied to indicate the real impact of the decreasing area of the green spaces. Various researches have been done that highlighted the issues. However, the previous studies done are mostly just a theoretical opinion.

At present, regulations in Malaysia require 10% of the land of every new housing development to be reserved for green space, but there is no stipulation on its quality. Thus, the green spaces are often left with no landscaping or sometimes as a bare open ground. The full potential of green spaces is not always realized, as the current management practices are sometimes sub-optimal. The policy also does not

give quantitative basis to quantify the needs for the provision. It is only arbitrary and no justification is given for the quantum.

Several case studies have highlighted critical policy needs and priorities for the development and management of urban green spaces (Baycan-Levent and Nijkamp, 2004). Therefore, it is very vital to compare and evaluate urban green space policies for identifying the best practices with a view to proper policy recommendations and guidance for urban society and planning authorities in order to improve the quality of life in modern cities.

This study is done to give a clear understanding on the impact of insufficient green spaces to the microclimate and the environment. This study is anticipated to be able to assist in the policy formulation relating to the green spaces and to assess whether the current regulations do not further heightened the situation.

1.2 STATEMENT OF PROBLEM

Presently, as rapid urbanization is causing the losses of even more urban green space across the globe. This may have negative implications on the global climate changes. The lack of open space in urban areas thus may result to environment problems (Lillian et al., 2002). Hence, it is very important for the urban green spaces to be preserved and promoted for future generation as they provide key ecological services.

Malaysia has experienced rapid economic development since gaining independence from the British in 1957, leading to the population growth which concentrated in the main conurbations of Malaysia, especially its capital city, Kuala Lumpur (Mohamed Ariff, 1998). The increase in Malaysia's urban population, together with aggressive industrial and economic growth, has caused rapid development in its urban areas placing great pressure upon the country's urban

environment. The conflict between the development and environmental protection is not new and much has been said about the environmental deterioration in Malaysia as the country strives to become a developed nation.

The increasing temperature of the urban areas or more known as the urban heat island effects have negatively impacts not only residents of urban-related environs, but also humans and their associated ecosystems located far away from cities. In fact, the urban heat island effects are believed to have cause the impact on the climate change due to their contribution to the greenhouse effect, and therefore, to global warming (Arrau and Pena, 2011). Although urban heat islands are distinctly different from the phenomenon of climate change, however, they can contribute to global warming during the summer months. The increased use of air conditioning and refrigeration needed to cool indoor spaces in a city with increasing temperatures may results in the release of more of the heat-trapping greenhouse gases that continuously contribute to the global warming. It has been reported that several cities has spend millions of dollars to offset the heat island effect.

Researchers have said that the surface temperatures can be affected by land use and suggested that local and regional strategies, such as creating green spaces and buffer zones in and around urban areas, could be a tool in addressing climate change. Thus, it is very important to understand the relationship between the urban heat island intensity and the urban green spaces to solve the issues and mitigate the urban heat island effects.

1.3 RESEARCH QUESTIONS

- i. What are the spatial arrangements of the land use components in the study areas?
- ii. What is the pattern of the surface temperature in the study areas and its relation to the urban form?
- iii. What is the relationship between the surface temperature and the green spaces in the study areas?
- iv. To what extent the relationship between the surface temperature and green spaces goes?

1.4 OBJECTIVES

- i. To analyse the pattern of the urban surface temperature in the study areas.
- ii. To analyse the spatial distribution of the green spaces of the study areas.
- iii. To compare the relationship between the urban surface temperatures and the urban green spaces.
- iv. To recommend a mechanism to reduce the urban temperature in the urban areas.

1.5 SCOPE OF STUDY AND LIMITATIONS

1.5.1 Scope of Study

The study explores the relationship between the urban temperature and the urban green spaces. The urban temperature consists of air temperature and surface temperature. This study will focus on the surface temperature because this is the only portion of the urban temperature that can be measured using satellite. Satellite images from LANDSAT 5 (TM) will be used to determine the pattern of the urban

temperature in the study areas. It will further be compared to the distribution of the green spaces in the study areas using GIS method.

The study areas chosen are Kuala Lumpur and Batu Pahat. The reasons for choosing the sites are based on their similarity to each other compared to other urban centres in terms of geographical location and topography. Both of the study areas will cover the city centres.

1.5.2 Limitations

There are two limitations that need to be acknowledged and addressed regarding the study.

i. Time constraint

The first limitation concerns the time needed for data collection. Obtaining the satellite images from the authority which is the Agency of Remote Sensing Malaysia (ARSM) may take more than two weeks, therefore may limit the time to analyse the data collected.

ii. Resources constraint

The second limitation has to do with the extent to which the data can be obtained. Due to the limitation of the satellite images, the data may be limited and not updated. The data from the satellite images may not be accurate as the temperature derived may be affected by external factors such as rainfall.

1.6 SIGNIFICANCE OF STUDY

This type of research will expose the modern planning system to an easier and more effective way to study the urban heat island effect compared to the conventional method. The uses of remote sensing and geographical information system methods have made it possible to perform the analysis at much larger scale than in the past. Besides that, remote sensing techniques are able to generate valuable data of the remote and inaccessible area such as the tropical forest and monitor the rapid changes in land cover.

Furthermore, this study will also be of beneficial to many stakeholders, namely;

i. Local authority

The output of the study will assist the authority in the formulation of future policies and enhancing of the existing policies to make it more relevant to the current and future needs. It will also be able to make the development guidelines more effective and relevant to the development needs.

ii. Planners and designers, particularly physical planner

The output of this study can be used in design provision and as input in the process of designing for the purpose of achieving a better and feasible design.

iii. Public

The study would help to increase the awareness among the public of their roles and contributions in addressing the issues. Besides that, the study would encourage them to do their part in preserving the environment.

The information from this study can also be utilised by any interested parties in addition to the current available data to be used in various field including the educational field to be used as references.

1.7 ORGANIZATIONS OF CHAPTER

The study is conducted in four stages. The first stage provides the theoretical background of the study. The second stage is the gathering of the primary and secondary data. The third stage includes the analysis of data and findings, and finally the fourth stage consists of conclusions and recommendations. The organizations of chapters are as explained below (Refer Figure 1.1).

Chapter 1 gives overall understanding on the impact of the urbanization on the green spaces in the urban areas that lead to the issues of the rising of temperatures in urban areas or what is commonly known as the “urban heat island effect”. The chapter also highlights the rationale of studying the relationship between the urban green spaces and the urban temperature and the justification for selecting Kuala Lumpur and Batu Pahat as the case studies. However, most importantly this chapter presents the objectives and the scope of the study.

Chapter 2 consists of the literature review regarding the urban temperature and urban green spaces. It also highlights the method of analysis of the satellite images using geographical information system (GIS) which are often used nowadays to determine the impact of the land coverage (including urban green spaces) that resulted to the changes on the surface temperature. The chapter also presents some examples of researches done on the relationship between the land cover types and the urban surface temperature in other countries.

Chapter 3 describes the study areas and discusses the various approaches of data collection in order to achieve the objectives and to answer the research questions. It gives a brief description of the study areas to allow further understanding of the sites. It explains the locations, characteristics and the land uses of the study areas. It also explains how the analysis is being done, the methods of data collection, the type of analysis used and ways in presenting the findings. Primary data used in this research consists of satellite images obtained from Malaysia Remote Sensing Agency (ARSM) while the secondary data consists of other studies, reports and maps relating to the research topic and was obtained from JUPEM and journals.

Chapter 4 presents the major analysis and findings. It displays the results of the analysis of the satellite images using ArcGIS software supported by literature review. This chapter attempts to achieve the overall objectives of this study. The results are then assessed and validated to prove whether the findings are reliable. The implications of the findings are further discussed.

Chapter 5 summarizes the whole research and draws conclusions based on the findings regarding the correlation between the green spaces and the surface temperature in the urban areas. This chapter also draws some recommendations to solve the issues discussed in the earlier chapter.

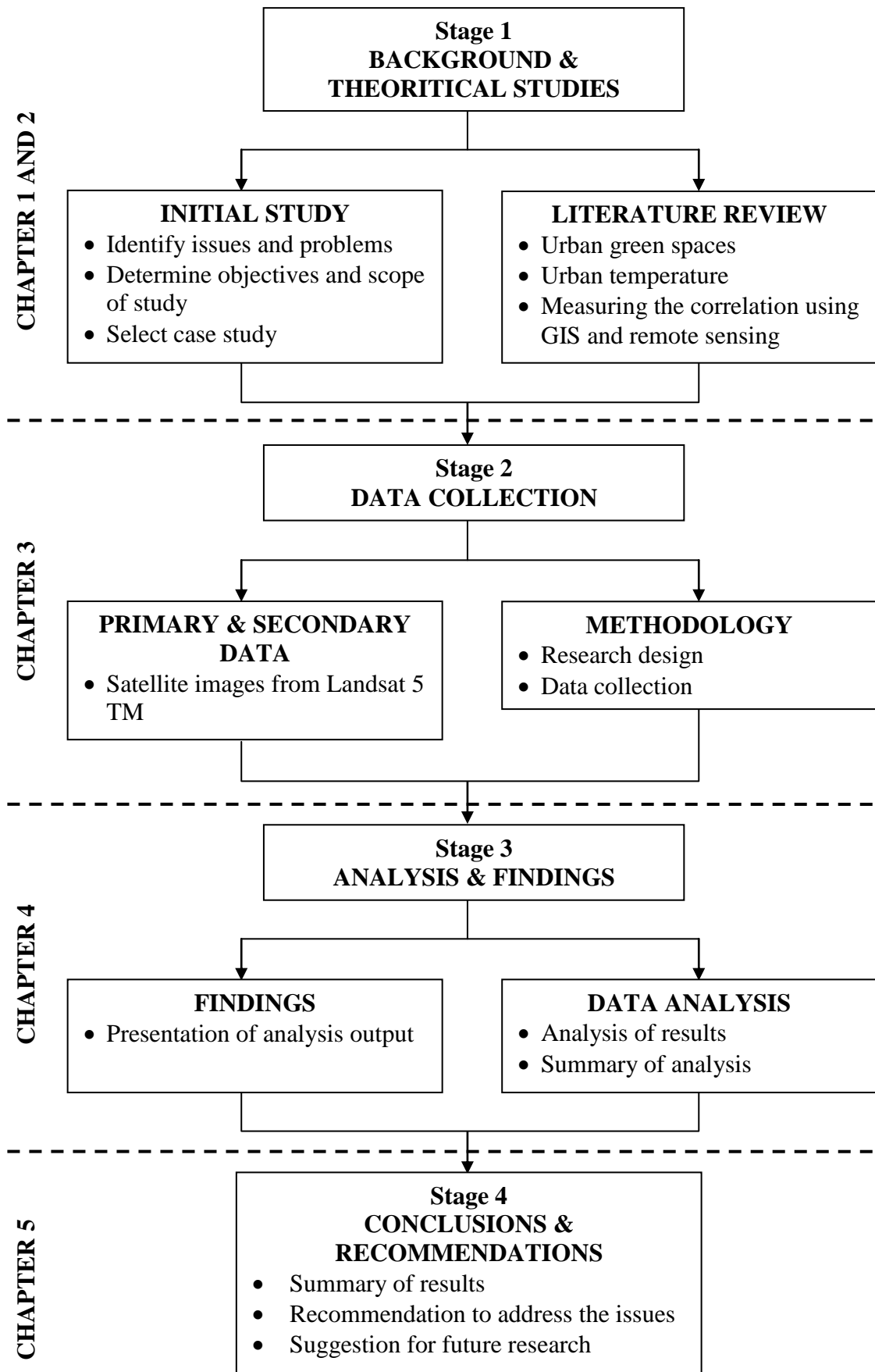


Figure 1.1: Flowchart of the Study Process