



الجامعة الإسلامية العالمية ماليزيا
INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA
بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

THE EFFECTS OF URBANIZATION ON THE
INTENSITY OF THE URBAN HEAT ISLAND: A
CASE STUDY ON THE CITY OF KUALA LUMPUR

BY

ILHAM SAYED MAHGOUB ELSAYED

INTERNATIONAL ISLAMIC UNIVERSITY
MALAYSIA

2006

Excerpt from Surah Al-ALAQ (Verses 1-5)

In the name of Allah, Most Gracious Most Merciful.

Read! In the name of thy Lord and Cherisher,

Who created-Created man, out of a leach- like clot:

Read! And thy Lord is Most Bountiful,-

He Who taught (the use of) the pen,-

Taught man that which he knew not.

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ILHAM SAYED MAHGOUB ELSAYED

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the Degree of
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International Islamic University Malaysia

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ABSTRACT OF THE THESIS

The focus of this study is on the effects of urbanization on the intensity of the urban heat island, through a case study on the city of Kuala Lumpur (KL), Malaysia. The study aims to identify whether there is a relationship between the level of urbanization and the intensity of the urban heat island of the city as well as to what extent this relationship goes. There are two methodologies followed in this study. Firstly, the methodology to study the urbanization process in KL by collecting data from secondary and primary sources of data and by reviewing the literature along with official documents. Secondly, there are two methodologies combined to study the horizontal nocturnal urban heat island of KL by using weather station networks method and traverses survey method. The parameters included for studying and measuring the levels of urbanization in the city are population density, traffic activity and land use change. Moreover, the three parameters are measured using traverses survey method; air temperature, relative humidity and wind speed levels. The study shows that, the level of urbanization is proportional to the values of temperature registered, while the temperature clearly varies from weekdays to weekends. The working days are relatively hot compare to non working days. Nevertheless, it is difficult to relate the relative humidity values only to working or non working days. The relative humidity can be related to green or non green areas, as well as to location and human activities among those specific areas. Furthermore, it is difficult to relate wind speed levels to the day of the week, while there is a strong relation between the wind speed levels and the location of the station. The further away the station from of KL city center, the higher the levels of wind speed. The study shows that, wind speed levels are inversely proportional to the level of urbanization of the city. The study indicates that, the increase in the intensity of the UHI of Kuala Lumpur City since 1985 reaches 1.5 ° C. Furthermore, it shows that, the location of UHI nucleus has shifted from Chow Kit area in 1985 to Puduraya area (2004). The study concludes that, the intensity of the UHI of the city is proportional to the commercial, road and rail reserves land use and inversely proportional to the open space and recreational, residential, industrial, institutional, and agricultural/ fishery/ forest land use. Furthermore, the intensity of the UHI is also proportional to the population density, number of cars and motorcycles vehicles, while it is inversely proportional to public transport vehicles. Therefore, the study concludes that, the level of urbanization is directly proportional to the intensity of the UHI of Kuala Lumpur City.

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APPROVAL PAGE

The thesis of Ilham Sayed Mahgoub Elsayed has been examined and is approved by the following:

Che Musa Che Omar
Supervisor

Allias Abdullah
Co supervisor

Mansor Ibrahim
Internal Examiner

Sham Sani
External Examiner

Ibrahim Zain
Chairman

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.

Ilham Sayed Mahgoub Elsayed

Signature.....

Date.....

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URBAN HEAT ISLAND: A CASE STUDY ON THE CITY OF KUALA
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To those dearer to me than myself:

My husband, Dr Osama Eltahir M. Babiker

My baby, Sayed Osama E. M. Babiker

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LIST OF ABBREVIATIONS

AMSL	Above Mean Sea Level
ASMA	Alam Sekitar Malaysia Sdn. Bhd.
AWS	Automated Weather Station
CBE	Centre for Built Environment (IIUM)
©	Copyright
Dec.	December
dept.	Department
DOE	Department of Environment
e.g	(exempligratia): for example
ed.	editor, edited by
et al.	(et alia): and others
etc	(et cetera): and so forth
Fig.	Figure
GIS	Geographic Information System
HVAC	Heating, Ventilation, and Air Conditioning
IIUM	International Islamic University Malaysia
KAED	Kulliyyah of Architecture and Environmental Design
KL	Kuala Lumpur
KLCC	Kuala Lumpur City Centre
KLIA	Kuala Lumpur International Airport
KLMR	Kuala Lumpur Metropolitan Region
KLSP	Kuala Lumpur Structure Plan
Km	Kilometer
LMT	Local Malaysian Time
MMS	Malaysian Meteorological Services
MLT	Malaysian Local Time
m/s	meter per second
No.	Number/ Numbers
RH	Relative Humidity
sq.	Square (meter, mile...etc)
S.W.T	Subhanahu Wa Ta'ala (Praise be to Allah and the Most High)
T °C	Temperature in Degree Celsius
TSP	Total Suspended Particulate
UHI	Urban Heat Island
UiTM	Universiti Teknologi Mara
UKM	Universiti Kebangsaan Malaysia
Vol.	Volume
VOCs	Volatile Organic Compounds
Vs	(Versus): against
WS	Wind Speed
SUST	Sudan University of Science and Technology

CHAPTER 1

INTRODUCTION

“In an urban setting, man, through his activities, has altered the climate in various ways. Firstly, urbanization changes the physical surface of the land; secondly, urban man and his activities produce a significant amount of heat which is important climatically...”

Sham Sani (1984c)

1.0 INTRODUCTION

The increased size of urban areas in terms of both their population and their land consumption has intensified adverse urban environmental impacts. Urban settlements provide one of the best examples of change in human activities and perceptions. Residential areas are constantly undergoing modification and expansion into areas that were formally occupied by agriculture and the natural environment. Man is altering the climate, which affects him and his activities through the building of cities. He has altered the climate by changing the physical surface of the land and producing significant amount of heat and pollutants.

Works done on the impacts of urbanization upon temperatures and definitely, on local climate in the Klang Valley area have been largely confined to Kuala Lumpur – Petaling Jaya area. One of the early publications on this subject was by Sham Sani (1972) who reported on the variations of temperatures for several observation stations

within the Kuala Lumpur – Petaling Jaya area. This was followed a year later by another publication on the observation of the effect of Kuala Lumpur urban area on temperature patterns (Sham Sani, 1973b). More comprehensive set of work on the impact of urbanization upon the atmospheric environment appeared during 1979 – 80 focus on air pollution climatology and local climate of the Kuala Lumpur – Petaling Jaya area (Sham Sani 1979, 1980). Then he added more in 1984, 1985. Sham Sani had participated in, if not all, almost all the previous similar work done. Therefore, this work stresses more in the status of the UHI of the city since 1985.

This thesis aims to study the effects of urbanization on the intensity of the urban heat island (UHI) through a case study on the city of Kuala Lumpur. Therefore it aims to analyze the urbanization process in the city of Kuala Lumpur and its effects on urban heat island of the city. The study used the GIS technology to establish the coloured contour maps of the UHI of the city for seven different days of the week. The intensity of the UHI of the city is compared during weekdays and weekends. Moreover the location of the nucleus of the UHI in 2004 has been identified and compare to its previous location in 1985. Furthermore, the study aims to find the difference between the present study and those of previous ones in terms of number and location of cool and heat islands.

This chapter seeks to identify and state the research problem. It discusses the purpose and objectives of this study. It furthermore, defines the research questions and hypotheses for the study as well as the scope and significance of the study. The chapter concludes with the limitations of the study, organization of thesis, and a brief summary for the whole chapter.

1.1 STATEMENT OF THE RESEARCH PROBLEM

One of the most outstanding features of urbanization and urban growth in Malaysia today is the dramatic growth and dominance of Kuala Lumpur, the federal capital of Malaysia. As cities grow, buildings and paved surfaces replace the natural landscape. Hard inert surfaces absorb heat, causing their temperature to rise steadily with increasing exposure. Dark colored surfaces like roofs, roads and parking lots absorb the greatest amount of heat. Large masses of tarmac, concrete and steel buildings absorb and store large amounts of heat, which in turn radiated into the surroundings.

In tropical metropolis, road and car park surface temperatures might exceed 60°C in the mid-afternoon when air temperature is in the 30s. As a result, temperatures in city areas can be 10°C or more above suburban green areas (Sham Sani, 1987). A large urban conglomerate like Kuala Lumpur will have numerous such concentrated build-ups of heat in-between areas of cool greenery. The observations of Sham Sani (1987) indicated that the commercial centers are usually several degrees warmer than the surrounding countryside. The intensity of the urban heat island varies from one city to another but in extreme case, a rural-urban temperature contrast of 20°F (11°C) has been reported (Sham Sani, (1990/1991). The situation in city areas is obviously more complex, following modification of the atmosphere by urbanization, pollution dispersion takes place in a manner different from that observed in rural areas. The most distinctive feature of Kuala Lumpur local climate is the mass of warm air, which commonly lies within and above the built-up area. Temperatures are normally higher in the central business district than in the rural areas around the city and the anomaly is usually greatest by night (Sham Sani, 1972 and 1973).

Rapid population growth exerts and aggravates pressures on living space with a consequent deterioration in environmental quality. The population density of the city

of KL has increased from 4009 person/hectare in 1980 to 4793 person/hectare in 2000 to 6085 person/hectare in 2004, and that is due to the increasing levels of urbanization of the city. The population density in the city also increased because of the increasing number of migrants searching for better working opportunities, services, and facilities (Brookfield Harold, Abdul Samad Hadi and Zaharah Mahmud, 1991). In the last two decades the city of KL experienced rapid changes in concentration of human activities and in the location of population. It has been occupied by multi stories buildings and tall commercial buildings that dominate the skyline, and they have a dramatic effect on the microclimates of the city (Sham Sani, 1990/1991). The continuous constructions in the city have replaced vegetation and greenery. Furthermore, human activities in Kuala Lumpur City intensify the amount of heat produced (Sham Sani, 1984c). Man has become a primary source of heat production from transportation systems, industrial plants, and heating ventilation and air conditioning (HVAC) systems that is installed for cooling the buildings to lower the internal temperature to suit human thermal comfort inside the buildings. Studies show that the urbanization and human activity are major factors in increasing the intensity of the UHI and contribute significantly as one of the causes of the urban heat islands.

The focus of the study is the effects of urbanization process in Kuala Lumpur on the urban heat island of the city, thus the research questions are:

- 1- What is the relationship between the levels of urbanization and the intensity of the urban heat island of the city of Kuala Lumpur? If there is a relationship,
- 2- To what extent this relationship goes.