STUDY ON LANDSCAPE ECOLOGY OF FERN SPECIES AS POTENTIAL ECOLOGICAL INDICATOR FOR URBAN ENVIRONMENT

BY

NUR HANIE BINTI MOHD LATIFF

A thesis submitted in fulfilment of the requirement for the degree of Master of Science
(Built Environment)

Kulliyyah of Architecture and Environmental Design
International Islamic University Malaysia

FEBRUARY 2014

ABSTRACT

This research explores the capabilities of fern species as phytoindicators to indicate microclimate changes at different elevations to facilitate productive future growth through the landscape ecology approach. The research collected 103 fern species from four sites, namely; Rimba Ilmu, UM; Taman Pakis, UKM; FRIM botanical Garden, Kepong and Putrajaya Botanical Garden. The sampled sites consisted of three types of habitat, namely; terrestrial (highland, lowland, highland and lowland), epiphyte (highland, lowland, highland and lowland) and aquatic (emerged and floater) as well as different characteristics such as shrubs, trees, climbers, groundcovers, epiphytes, and aquatics. From this sample, the research concluded that different elevation meant different fern species. At higher elevation, there were more diverse fern species. In this research, observation and measurement were made based on two different natural environments, namely; Gunung Jerai, Kedah, and Lata Jarum, Pahang. Interestingly results from the two case studies indicated that the distribution and abundance of fern species was strongly influenced by differences in altitude. Twelve fern species were found at different elevations at Gunung Jerai, Kedah, whereas 20 fern species were found at Lata Jarum, Pahang. Among the species found at Gunung Jerai were *Selaginella willdenowii, Arcypteris irregularis*, *Adiantum caudatum*, *Pityrogramma calomelanos*, *Histiopteris stipulacea, Athyrium cordifolium, Osmund wachellii*, and *Cyathea contaminans.* Whereas the species found at Lata Jarum are *Dicranopteris linearis, Phymatodes scolopendria, Antrophyum callifolium, Arcypteris irregularis, Phymatodes crustachea*, *Selaginella willdenowi*, *Angiopteris evecta and Aglaomorpha heraclea.* The research also found the urban climate differs complete to natural ecological climate. The urban microclimate is hotter than the natural microclimate ecology. In conclusion, fern species has a close relationship with elevation as well as microclimate changes. In regards to the urban environment, the research studied the coastal urban environment with the T < 26°C, RH >60 % and LI < 800 lux, namely Gunung Jerai, whereas for the inland urban environment such as Kuala Lumpur with the T <27 °C, RH >80 % and LI < 1500 lux, sampled environment was Lata Jarum.

ملخص البحث

الهدف من البحث هو توضيح فعالية وقدرات نباتات الختشار كمؤشر للنباتيه يشير الى بيئه بارتفاعات مختلفه وتغيرات طفيفه لتمكين تطورهم المستقبلي والمحتمل من خلال نهج البيئه لمناظر البساتين . أهداف البحث الثلاثه قد تحققت . في الهدف الاول , كان هناك مئة وثلاثه قطعة من نباتات الخنشاؤ جمعت من أربع اماكن , رمبا المو – يو بي ام , كمان باكس – يو كي ام , وحديقة فرم بوتانيكال , وحديقة كيبونج وبوتراجايا . كان هناك ثلاث أنواع من المواطن , أرضي (منطقة جبلية , منطقة منخفضة , منطقة جبلية ومنخفضة) وهوائي (منطقة عالية , منطقة منخفضة , منطقة عالية ومنخفضة) ومائي (مغمور وعائم) واضافة الى ذلك خصائص مختلفة مثل الشجيرات , الاشجار, متسلق , غطاء ارضي , هوائي ومائي . الهدف الثاني اثبت ان هنالك خصائص مختلفة لنباتات الختشار عند ارتفاعات مختلفه . كلما زات الارتفاع كلما زاد التنوع والاختلاف .في هذا البحث , الملاحظات والقياسات اخذت في بيئتين طبيعتين مختلفتين هما , جوننج جيرج , كدح ولاتاجيرم باهانج . النتائج المثيرة للاهتمام التي حصل عليها من دراسة البيئتين الطبيعتين اشارة الى ان توزيع ووفة نباتات الختشار تأثر بشكل قوي باختلاف الارتفاع الزاوي . اثنتي عشر قطعة من نباتات الختشار وجدت بارتفاعات مختلفة في جوننج جيرج , وكدح في حيث عشرون قطعة وجدت في لاتا جاروم باهانج . من بين القطع التي وجدت في جوننج كان سيلاجينيلا ويلدينووي , ايركيبترز اريجيولار , اديانتم كابوداتم , بايتيروجلاما كالوميلانس , هستيوبتسيرز ستبيولاسيا , ايرم كارديفوليوم , اوسموند واشيلي وكايثيا كونتامييننز . في حين ان القطع التي وجدت في لاتا جاروم هي ديكرانوبتريس لينيريز , فايماتوديس سكولوبيندريا , انترافوم كاليفوليوم , ارسايبتيرز ايجيولار , فايماتوديس كرستاشيا , سيلانجينيلا ويلدنووي , انجيو بتيرز ايفيكتا , اجلامورفاهيراكليا . الهدف الثالث اثبت ان مناخ المناطق النائيه مختلف كليا عن مناخ البيه الطبيعي او المحمي . مناخ المناطق النائية اكثر سخونة من مناخ المحميات الطبيعية . في الختام , قطع نباتات الختشار لها علاقة قوية مع الارتفاعات والتغييرات الطفيفة في المناخ . اعتمادا على البحث , ان هنالك نوعان من المناخ أو البيئه موصى بتطبيقها في البيئه النائيه : في البيئة الساحليه عند درجة حراره <26 درجة سيليسيوسية , الرطوبة النسبية > 60% وشدة الضوء < 800 لكس فان البيئة المناسبة هي البيئة التابعة بجيرج في حين ان بيئة المناطق النائية الداخلية مثل كولالمبور بدرجة حرارة <27 درجة سيليسيوسية , الرطوبة النسبية >80% وشدة الضوء <1500 لكس فان البيئة المفضلة كانت مثل لاكا جاروم .

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 thesis for the degree of Master of Science (Built Environment).

……………………..…………
Izawati Tukiman
Supervisor

……………………..…………
Rashidi Othman
Co-Supervisor

I certify that I have 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 thesis for the degree of Master of Science (Built Environment).

……………………………........
Maheran Yaman
Internal Examiner

……………………....................
Mohamad Abu Bakar
External Examiner

This thesis was submitted to the Department of Landscape Architecture and is accepted as a fulfillment of the requirement for the degree of Master of Science (Built Environment).

……………………………........
Nor Zalina Harun
Head, Department of
Landscape Architecture

This thesis was submitted to the Kulliyyah of Architecture and Environmental Design and is accepted as a fulfillment of the requirement for degree of Master of Science (Built Environment).

…………………………….......
Khairuddin Abdul Rashid
Dean, Kulliyyah of Architecture
and Environmental Design

DECLARATION

I hereby declare that this thesis 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.

Nur Hanie Binti Mohd Latiff

Signature……………………………… Date …………………………………

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

DECLARATION OF COPYRIGHT AND AFFIRMATION OF FAIR USE OF UNPUBLISHED RESEARCH

STUDY ON LANDSCAPE ECOLOGY OF FERN SPECIES AS POTENTIAL ECOLOGICAL INDICATOR FOR URBAN ENVIRONMENT

No part of this unpublished research may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without prior written permission of the copyright holder except as provided below.

1. Any material contained in or derived from this unpublished research may only be used by others in their writing with due acknowledgement.

2. IIUM or its library will have the right to make and transmit copies (print or electronic) for institutional and academic purposes.

3. The IIUM library will have the right to make, store in a retrieval system and supply copies of this unpublished research if requested by other universities and research libraries.

Affirmed by Nur Hanie Binti Mohd Latiff

…………………….	……………………….
Signature	Date

ACKNOWLEDGEMENTS

Bismillahir Rahmanir Rahim….

First and foremost, I would like to praise my deepest gratitude to Allah S.W.T. the most gracious and the most merciful, peace and blessings upon his messenger Prophet Muhammad peace be upon him.

There are a lot of people I would like to thank for being involved, in one way or another, in the implementation of this thesis. First and foremost I would like to express my deepest gratitude and utmost appreciation to both of my supervisors Associate Professor Dr. Rashidi bin Othman and Assistant Professor Dr. Izawati binti Tukiman for their warm encouragement and invaluable advice as well as their professional insight and constructive criticism. Without them, this work could never success and become a reality.

Many thanks are also due to my family members, my brothers and my sisters (Mohd Hafeiz Mohd Latiff and Nor Wahida Rahman, Muhammad Hadi Mohd Latiff, Nur Hanum Mohd Latiff, Nur Hanis Mohd Latiff, Muhammad Hakim Mohd Latiff, Hazleen Ahmad and Ahmad Jinaem Shamsuddin, Hafeez Ahmad and Roslina Md Tapah) for their support, du'a and much good advice. Also dedicated to my lovely nieces and nephews for cheer up my day (Ahmad Hafeey, Haneef, Ameera Husna, Hazween, Hazaunee, Hazainee, Ameera Haziqah and Nur Hafizah Husna). I also would like to extend my special thanks and love to my parents, Mohd Latiff Mohd Yasin and Rasilah Ibrahim, and parents in law, Ahmad Rosslin and Hamidah Mohammad for their prayer, love, understanding, and support through the years. I will treasure that gracious gift above all others for the rest of my life.

I acknowledge with gratitude and lots of love the help of my dear husband Hazree Ahmad, who patiently endured the recital of my thesis at all hours of the day and night, and who often saved me from the grosser forms of solecism.

Finally, I would like to thank the friends that I've met, support and advised a lot during exploring and handling equipments, contribute directly and indirectly in the process of experiment and completing the thesis at Herbarium Lab, Kuliyyah of Architecture and Environmental Design especially Sis. Hafizana, Sis. Fatimah Zahra, Sis. Nor Yusnida, Sis. Shazila, Sis. Razanah, Sis. Ruhul 'Izzati, Sis. Azleen, Sis. Qurratu Ain, Sis. Farah Ayuni and for all those name not mentioned. Your infinite support is much appreciated.

Last but not least,
This thesis is humbly dedicated to the Ministry of Higher Education who granting me the scholarship to pursue the Master Degree and Department of Landscape Architecture, Kuliyyah Architecture and Environmental Design, International Islamic University Malaysia.

Alhamdulillah…

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

%	Percent
<	Less than
>	More than
°C	Degree celcius
ACIA	Artic Climate Impact Assesment
ADB	Asian Development Bank
Al	Aluminium
$CH4_4$	Methane
CO_2	Carbon dioxide
Cr	Cromium
EPA	Environmental Protection Agency States
FRIM	Forest Research Institute of Malaysia
GHG	Green House Gasses
GJ	Gunung Jerai
IEC	International Electrotechnical Commission
IPCC	Intergovenmental Panel on Climate Change
ISO	International Organization for Standardization
LI	Light intensity
LJ	Lata Jarum
m	Meter
MGF	Malaysia Green Forum
MOSTE	Ministry of Science, Technology and Environment
NH	Northern hemisphere
OU	One Utama
PET	Potential evapotranspiration
RH	Relative humidity
SKVE	South Klang Valley Expressway
T	Temperature
UHI	Urban Heat Island
UKM	Universiti Kebangsaan Malaysia
UM	Universiti Malaya
UNEP	United Nation Environmental Programmed
UTM	Universiti Teknologi Malaysia
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 RESEARCH BACKGROUND

In this rapidly changing world, human beings are an active force of nature that orchestrate change that often result in changes in ecosystems, which can be a potential threat or future generations. Changes in climate is an example of such potentially disastrous changes. The greenhouse gases released into the atmosphere have caused global warming. The most threatening greenhouse gas is carbon dioxide gas which is emitted in energy production and transportation. Greenhouse gases have been at the heart of industrial development for the past 200 years.

This study discusses microclimate changes that result from the development of urban areas. It focused on determining the level of heat contribution to the microclimate within the city centre within the context of an urban heat island. To achieve this, a suitable mechanism is required to forecast microclimate changes in urban area. This study uses to ecological indicators as indicator for micro climate changes with a focus on ecology of fern species.

Other than the utility of fern species in ethno botany uses such as food and medicine, fern species have a number of ecological values. For example, ferns absorb methane gas, fertilize the land and serve as ecological indicators for microclimate. This merits their use as ecological indicators to treat an unhealthy environment.

1.2 PROBLEM STATEMENT

Fern species serve many functions in landscape ecology besides being a natural or ornamental landscape. Their value as natural indicators is largely unknown or overlooked. Therefore, this research seeks to emphasize their utility as a phytoindicator to threat an unhealthy environment.

1.3 ISSUES

1.3.1 Climate changes

From 1997 to 2008, the world experienced 31 % of Carbon dioxide (CO_2) released into the air, which resulted a 1.5 inch rise in sea level that caused by the melting of ice bergs. Developed countries such as Japan and United States released 37.5% of CO_2 which impacted heavily on Southeast Asia especially along the coastline population, forestry, and agriculture (Abd Samad, 2009). The Asian Development Bank (ADB) noted that, every 1°C in temperature rise negatively effects the coastline. The function of CO_2 and Methane ($CH4_4$) are to stabilize the temperature however, excessive amounts of those gasses trapped in the atmosphere will be absorbed by the sea and result in global warming by increasing sea level and temperatures. In addition, rapid urban growth also contributes to greenhouse gases because the carbon is not cycled naturally (Zhang, 2008).

1.3.2 Urban Heat Island (UHI)

Described by Oke (1982), urban heat island (UHI) is an indicator to measure differences in temperature between urban and suburban areas. Differences in temperature result from the urban surfaces’ thermal emissivity properties, the configuration of three-dimensional, and also from the erected structures’ heat capacity which affect urban temperature patterns. Most cities throughout the world showed urban are higher temperatures in the centre more than it's surrounding. Except for the regions of arid or semi-arid, the irrigated gardens may be coolening the city centre. UHI directly affected thermal comfort and health of human's in the cities (Harlan et al., 2006; Lafortezza et al., 2009; Stafoggia et al., 2008). Changes in patterns of temperature also influenced the ecology of urban by altering habitat of the species (Knapp et al., 2008) and influencing dynamics of vegetation in the city such as bud-bursts beginning (Luo et al., 2007; Roetzer et al., 2000; Shustack et al., 2009).

1.3.3 Climate changes in the Malaysian context

Climate changes are the biggest threat to mankind in the 21^{st} century. Climate changes have caused fluctuations in global. There has been a steady increase in temperatures over the past 30 to 50 years. This has caused increased extreme weather events in frequency and intensity such as drought, storm and flood. The global climate changes effects are varies. The climate changes are resulted by the emission of carbon dioxide (CO_2) trapped in the atmosphere released from vehicles, industry, power plants, and deforestation. When this gas builds up, they act like a thick blanket, overheat the planet, change the climate, and threaten human's health, economy, and natural environment. An analysis study of temperature in Malaysia showed a trendy warming effect. The temperature increased from +0.7°C until +2.6°C, while the precipitation changed from -30% until +30%. The climate changes phenomenon in Malaysia showed a negative impact on habitats of human beings such as agriculture, forest, water resource, coastal resource, health, and energy sector. (Haliza, 2009)

1.4 RESEARCH QUESTIONS

Referring to the problem statement mentioned above; the specific questions to be addressed in this research are outlined below:

i. What are ferns and their ecology?

ii. What are the suitable environments of ferns?

iii. What is an urban microclimate?

iv. What type of fern species can forecast microclimate changes?

1.5 RESEARCH AIM AND OBJECTIVES

This study explores the capabilities of fern species as phytoindicators to indicates unhealthy environments at different elevations and to detect micro climate changes in order to enable their future enhancement and potential through landscape a ecology approach. Listed below are the objectives of this research:

i. To study the habitats and the characteristics of fern species;

ii. To explore the correlation between fern species richness, micro climate changes, and gradient altitude; and

iii. To determine the potential of fern species to treat unhealthy environments.

1.6. HYPOTHESEIS

i. Fern species can be used as phytoindicators to treat unhealthy environments.

ii. Different microclimates or environmental factors will influence fern species richness at different altitudes or topography.

1.7 SIGNIFICANCE OF THE RESEARCH

i. Potential of fern species as phytoindicator to treat harsh environments;

ii. Landscape ecological approach to detect microclimate changes at lowland latitudes; and

iii. Landscape ecological approach to detect microclimate changes at high altitudes.

CHAPTER 2

LITERATURE REVIEW

2.1. CLIMATE CHANGES

Climate change is a global environmental problem. A number of studies have addressed issues pertaining to climate changes from the perspective of environmental policy. Such studies recognised that variability in climate changes, extreme events, and changes in structural were the major impact on economics, socials, human living conditions, and natural systems. It was found that in developing countries, the poverty reductions, waters, foods, energies, educations and healths are significantly influenced by climate change. Therefore, measures adaptation should be tackled in the development policies context.

According to Dow & Downing (2006), the climate changes were a statistical significant variation in the signify condition either in its variability or the climate, continuing for a period extention, typically in decades or longer. Dow and Downing also stated that climate change may be due to internal processes of natural or external radiative forcing, or to changes of persistent anthropogenic in the composition of the atmosphere or in land use. In February 2007, Intergovenmental Panel on Climate Change (IPCC) reported that the warming is unequivalent in our climate system due to the boost in global temperatures of air and ocean resulting in widespread snow and ice melting as well as sea levels rising (Dow & Downing, 2006). Observation on animals and plants by naturalists suggest that ecosystems are adjusting. The IPCC (2007) reported that recent global warming has affected the terrestrial, marine, and freshwater biological systems as well as the glaciers and rivers. Besides, according to 29,000 data sets that had been analised in 75 sites around the world, over 90% of the observations done were consistent with climate change. A single extreme weather conditions or change in the natural environment does not prove that human caused the changing of the climate however the history and consistency in assessment supported the emission of greenhouse gases by human activity. Before 1750, CO_2 was released approximately 280 ± 10 ppm or 512 ± 18 mg m^{-3}. Whilst in 1950, 1.6 billion tons of CO_2 was released per year globally. By 1997, CO_2 emissions had reached 7.0 billion tons per year which showed that the global absorptions of greenhouse gases had increased progressively. By the middle of 19th century, atmospheric absorptions had grown from 280 ppm to 380 ppm (Office of Science and Technology Policy, 1997; IPCC, 2007). The global climate model indicates that an increase in the surface temperature of 1.5°C to 4.5°C is possible in the next hundred years. Late in the 19th century, European scientists began to examine the historical weather condition records of the large European cities, including Paris, Berlin, Vienna, and London and detected the presence of the urban induced "heat island" (Landsberg, 1956). Urban areas alter their radiation balance and add sensible heat so that they are warmer than surrounding rural areas. European studies or urban climates also identified changes in humidity, wind speeds and radiation within the larger cities (Landsberg, 1970).

By 2100, it was predicted that the temperature will rise 0.6°C and warming rise between 1.4°C - 5.8°C will increase the sea level about 0.009 - 0.88 m (IPCC, 2001). The IPCC AR4's latest report had stated that the temperature had increased by 1906 till 2005 which about 0.76 [0.56 to 0.92]°C. Observation data collected from all continents and oceans showed that numbers of natural systems experienced increased temperatures in regional climate changes. Global surface temperature had increased 1.4°C and 5.8°C since 1990 until 2010. Since 1978, the Arctic sea ice extent averagely has shrunk up to 2.7 [2.1 until 3.3]% per decade. The global sea level rose up to 1.8 [1.3 until 2.3] mm per year since 1961 to 2003. It increased from 1993 until 2003 at 3.1 [2.4 until 3.8] mm per year (IPCC, 2007). Over 1961 - 1990, changes in the northern hemisphere (NH) showed an average reading in temperature, sea level, and snow. The temperature reading showed an increment of 0.74^{o}C since 1961 - 2003. The global sea level has risen about 1.8 mm since 1961 until 2003 and 3.1 mm throughout the 1923 until 2003. However, NH Snow Cover decreased ~2 million sq. km throughout the year 1920 until 2003 (IPCC, 2007). Thus, the effect can be seen through the changes of mountain glacier decline, polar sea-ice shrinking, net losses from Greenland, permafrost top warming, ocean warmed, changes in precipitation patterns and drought and last but not least decrement of ocean acidification 0.1 in surface pH (Wan Azli, 2010). On the other hand, ACIA, (2005) and IPCC, (2007) predicted that arctic temperatures will increase from 3°C up to 8°C till the next century and affect the biogeochemical system in the Arctic including a speed up of carbon losses stored in soil resulting from temperature and increase the microbial motion (Dorrepaal et al., 2009), induce high primary productivity as well as boost the carbon sink strength which neutralizes carbon losses from the soil. Climate changes were expected to modify biodiversity, exchange phenology, modify composition of genetic, exchange ranges of species, as well as affect interactions of species and processes of ecosystem (Walther et al. 2002; Root et al. 2003). Other authors such as Rosenzweig et al. (2001) considered the ways climate changes might affect pests including crops or species that caused human disease. Invasive species also responded to modify climate changes, ecologies, and economic values. For example, climate changes can be effected on aquatic species. Climate change affected aquatic ecosystems through increased water temperatures, altered patterns of river flow, and increased events of storm (Poff et al., 2002). These changes were expected to have profound effects on the distribution and phenology of species and the productivity of aquatic ecosystems (Parmesan, 2006). When the rise of air temperature occurs, water temperature also increases. This resulted in abundance of ectothermic aquatic organisms. The temperature is important in their physiology, bioenergetics, behaviour, and biogeography (Rahel, 2002).

In the assessment of Intergovernmental Panel on Climate Change (IPCC), Malaysian climates had encountered similar trend since previous years temperature changed up to 0.18^{o}C per decade since 1951 (MOSTE, 2000; Bindoff et al., 2007; Trenberth et al., 2007). UTM (2007) showed the sea level increased by approximately 1.25 mm along the southern coastal area of Peninsular Malaysia since 1986. Due to the impact of extreme weather, abnormal severe floods occurred over Peninsular Malaysia during the winter monsoon of 2006/2007 and 2007/2008. Almost all states are affected including Perlis, Kedah, Selangor, Kuala Lumpur, Johor, Pahang, Kelantan and Terengganu as illustrated in Table 2.1.

Table 2.1
Extreme weather events in Malaysia 2006-2009 (Wan Azli, 2010)

Date of Event	Events	Location
19 April 1998	Highest temperature (40.1 ^{o}C)	Chuping, Perak
13 February 2006	Heavy flood	Terengganu
19 April 2006	Heavy flood	Kelantan
2006	Water spout	Kudat
14 Jan 2007	Heavy flood	Kuala Lumpur
9 Jan 2008	Heavy flood	Kedah
29 Sept 2008	Haze	Kuala Lumpur
18 December 2008	Heavy flood	Perlis
19 April 2009	Typhoon	Kelantan
3 March 2009	Heavy Flood	Kuala Lumpur

2.1.1 Possible Causes of Climate Change

There were many theories attempting to explain climate change but none of them can give a complete explanation of all the changes. The major problem is the relationships and interactions among the physical components of the climate system. Thus, although we give here some possible causes of climate changes, only knowledge and understanding of the majority of them can give a full understanding of the problem. As outlined by Asimakopoulos (2001), there are several possible reasons of climate change, namely:

i. Variations in solar radiation;
ii. Variations in the geographic location of continents on Earth’s orbit;
iii. Changes on location and orientation of mountain ranges;
iv. Variations within the atmospheric chemistry;
v. Variations of plants growth on the ground surface; and

vi. Climate changes in the urban environment.

2.1.2 Impact of climate changes

Due to the global changes of climate change, there are several impacts that cause positive and negative impacts although greater negative effects are expected. Changes of climate affect the environment, society, public health, and economy to name a few. According to Ogawa (2007), public health is disturbed when changes in climate occurs. Heat-related incidents in Europe and Asia such as air pollution and dengue are certain disease born from modification of nature. Such disease risks are significant and concentrated on the poor. Consideration of upgrading the public health where co-benefits action in protecting health by reducing the Green House Gasses (GHG) emissions through building, industry, agriculture, transport, energy supply and conversion and waste management (Ogawa, 2007).

2.2. URBAN HEAT ISLAND (UHI)

Air temperature in a compactly built urban environment is higher than the temperatures of nearby suburban nation. This is known as the ‘urban heat island’ and was first noticed by meteorologists more than a century ago. It is the most well documented phenomenon of climate modification (Howard, 1883). In reference to Landsberg (1981), the heat island was presented in every town or city was the most obvious climatic manifestation of urbanization. The temperature variation was usually greater at night than during the day, and is particularly obviously when the wind was weak. According to Environmental Protection Agency States (EPA), the yearly mean air temperature of a city with 1 million people or more can be 1°C – 3°C warmer than its surroundings. In the evening, the variation can be as high as 12°C (EPA, 2007).

According to EPA (2007), the warmth islands formed as vegetation was being replaced by asphalt and concrete for roads, buildings and other structures that necessary to accommodate growing populations. These reflected sun heated surface temperatures and overall ambient temperatures to arise. Moreover, UHI occurs because of energy balance's modification where natural surfaces are paved and built, and when activities of human releases heat into the local environment. One of the factors that may influence the formation of the urban heat island are related to the local setting, others to the activities undertaken, the volume of the city itself, and the mass of its population. In other words, the influence of the urban heat island is not only dependent on the transformation of the physical urban environment by buildings, it is also influenced by human activities and population growth. However the presence of buildings also affects the rate of heating through changing of surface albedo. The colour of surfaces reflect the rate of absorption of heat, darker surfaces absorb more sunlight than lighter surfaces. Urban surfaces such as asphalt streets and roofing materials have lower albedo than natural surfaces. Communities are affected by heat islands through increase in energy demand, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and mortality, and water quality.

2.2.1 Causes of UHI

Higher urban temperatures have serious impact on electricity order for building's air condition and increased haze productivity, as well as contributing to increase emission of contaminants from power plants, sulphur dioxide, carbon monoxide, nitrous oxides and suspended particulates (Santamouris, 1999). The phenomenon on the urban heat island was characterized by an important spatial and sequential variation related to climate, topography, physical arrangement and temporary weather conditions. A detail