Evaluating the Effect of Non-green Buildings on Urban Heat: Case Study in Kota Bharu

by

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DECLARATION

I declare that this thesis entitled “Evaluating the Effects Non-Green Buildings on Urban Heat: Case Study in Kota Bharu” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ____________________________

Name : ____________________________

Date : _________________________

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ABSTRACT

This research provides an overview of the effect of non-green buildings on urban heat. Objectives of this research was to evaluate the effect of the high rise non-green building in the urban area by calculating the Sky View Factor of the non-green buildings and to evaluate the trends of the temperature by comparing the current data with the backdated data of Kota Bahru, Kelantan. The research was done in Kota Bharu, Kelantan by applying Sky View Factor (SVF) calculations and comparison between current temperature of the buildings in midtown Kota Bahru with backdated temperature reading acquired from Malaysia Meteorology Department stationed in Kota Bahru. The results highlighted that Kota Bharu encountered urban heat phenomenon and this analysis shows the surrounding and building material directly influence the formation of urban heat. The highest temperature recorded was 42^{o}C on top of Kelatan Trade Center building whilst the lowest was 30^{o}C at Ibu Pejabat Polis Kontinjen Kelantan.

Menilai Kesan Bangunan Bukan Hijau Terhadap Haba Bandar: Kajian Kes di Kota Bharu

ABSTRAK

Kajian ini memberikan gambaran keseluruhan mengenai kesan bangunan bukan hijau dengan haba bandar. Objektif kajian ini adalah untuk menilai kesan bangunan bukan hijau di kawasan bandar dengan pengiraan nilai Sky View Factor bangunan-bangunan bukan hijau dan untuk menilai trend suhu dengan membandingkan data semasa dengan data lampau Kota Bahru, Kelantan. Kajian ini dijalankan di Kota Bharu, Kelantan dengan menggunakan Sky View Factor pengiraan dan perbandingan antara suhu semasa bangunan di tengah bandar Kota Bahru dengan bacaan suhu lampau yang diperolehi daripada Jabatan Meteorologi Malaysia distesen di Kota Bahru. Keputusan menyatakan bahawa Kota Bharu mengalami fenomena haba bandar dan analisis ini menunjukkan keadaan sekitar dan bahan pembuatan bangunan secara langsung mempengaruhi pembentukan haba bandar. Suhu tertinggi yang dicatatkan adalah 42^{o}C di atas Pusat Dagangan Kelatan bangunan manakala yang terendah adalah 30^{o}C di Ibu Pejabat Polis Kontinjen Kelantan.

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Urban heat happened where the surface temperatures of the buildings were high in urban areas where development was centralized, represents one of the most significant human-induced changes to Earth's surface climate. According to Valazquez (2002), the recorded index of the urban heat island is the increase of air temperature. In this study, a group of high rise non-green buildings was analyzed in order to determine its contribution to urban heat. This study was done in the center of Kelantan, Kota Bharu and was inspired by the desire to prove that the conventional way of high rise building is affecting the Earth's surface climate. A non-green building does not practice the green project concept which involved the practice of increasing the efficiency while reducing building impact on human health and the environment. Climate change, which is caused by increased anthropogenic emission of carbon dioxide and other greenhouse gases, is a long term effect with the potential to alter the intensity, temporal pattern, and spatial extent for the urban heat in metropolitan regions (Cynthia *et al*, 2005). Example of urban heat phenomenon can be seen in rapid progressing cities like Chicago and Vancouver in the United States. To trace urban heat, Sky View Factor was calculated. Sky View Factor involved the radiation exchange between urban surfaces and the sky (Svensson, 2004).

1.2 Problem statement

Over the recent years, many studies had been conducted to improve the knowledge upon environmental issues and continue to be an important part of green initiative demand in developed countries. However, such approach was a setback to develope and undeveloped countries. Urban heat phenomenon may had happen for a while now, but in Malaysia, the number of research done upon it is very minimal. The study is also mainly focus on larger cities like Kuala Lumpur or Johor Bharu. A study on urban heat in Kota Bharu had never been done before and this was a problem since without a proper research conclusion, mitigation measures are hard to conduct.

Lack of awareness towards sustainability importance is still a major issue in Malaysia. This is probably due to limited exposure. But since our earth started to show its degrading quality, people tend to approach more to improve the environmental conditions for all living organisms. This is due to an increased awareness about the environment and at the same time also due to an increased awareness amongst the consumers (Alias *et al.*, 2010).

1.3 Objectives

1. To evaluate the effect of the high rise non-green building in the urban area by calculating the Sky View Factor of the non-green buildings.
2. To evaluate the trends of the temperature by comparing the current data with the backdated data of Kota Bahru, Kelantan.

CHAPTER 2

LITERATURE REVIEW

2.1 Urban Heat Island

Pavement, dark-colored roofs, and similar surfaces absorb more sunlight, trap heat, and increase local temperatures. Urban areas tend to have more roads, buildings, and parking lots and less green space. The high concentration of these heat-absorbing surfaces creates an isolated area where higher temperatures are more likely. Studies have documented that urban areas have air and surface temperatures that are, on average, 1.8 – 5.4°F higher than temperatures in surrounding rural areas, and there is potential for up to a 22°F difference in more extreme situations (EPA-RUHI, 2010). Urban heat profile shown in Figure 2.1 shows the temperature is higher in downtown as compared to other places.

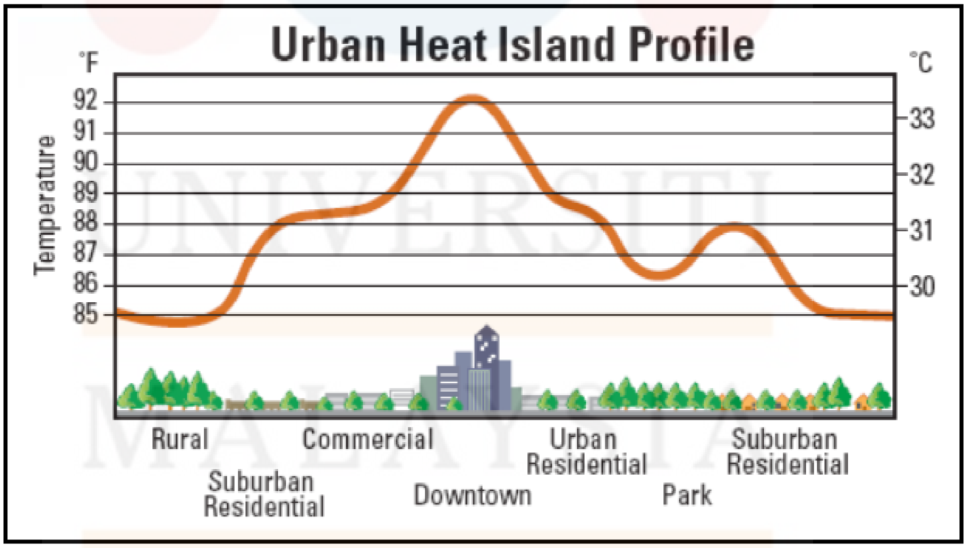


Figure 2.1: Urban Heat Island Profile. Source: US EPA Cooling Summer Temperatures: Strategies to Reduce Urban Heat Islands Brochure.

Urban heat phenomenon happen due to many factors (Oke *et al.*, 1991). Based on their research, he concluded that the most important factors are the contribution of canyon radiative geometry to the decrease in long-wave radiation loss from within the street canyon. This happens because of the complex exchange between buildings and the screening of the skyline. Other than that, the thermal properties of materials, which increase storage of sensible heat in the fabric of the city. Urban Heat also happen due to the anthropogenic heat released from combustion of fuels and animal metabolism and the urban greenhouse, which contributes to the increase in the incoming long-wave radiation from the polluted and warmer urban atmosphere.

Besides that, the canyon radiative geometry, which decreases the effective albedo of the system because of the multiple reflection of short-wave radiation between the canyon surfaces. Next factor is the reduction of evaporating surfaces in the city, which means that more energy is put into sensible heat and less into latent heat. Lastly, the reduced turbulent transfer of heat from within streets is also the reason why urban heat phenomenon happens (Oke *et al*., 1991).

2.2 Green Building Index (GBI)

Green building rating system by its nature and role is very dependent upon location and environment. GBI is Malaysia's very own green building rating system has been launched by the government and is known as Green Building Index (GBI). GBI is Malaysia's industry recognized green rating system for buildings to promote sustainability in the built environment and raise awareness about the environmental issues and responsibility for the future generations (Tan, 2009). These efforts will provide fresh challenge for the Malaysia construction industry to practice sustainable development and at the same time providing highest quality of affordable green building.

The objective of GBI is to save energy, resources, recycle materials and adapt buildings to the Malaysia climate, culture and environment. The rating of buildings based on GBI is centered on six major areas vis-a-vis indoor environment quality, energy efficiency, materials and resources, sustainable site planning and management, water efficiency, and innovation. Essentially the Malaysian Green Building Index is aimed at establishing a common language and standard of measurement; promote integrated whole-building design; recognize and reward environmental leadership; ensure that new buildings remain relevant in the future and existing buildings are refurbished and upgraded properly (Darus *et al*, 2009, Baharuddin *et al*., 2011).

2.3 High Rise Building

A high rise building have the potential to decongest the urban sprawl on the ground level, and increase the urban density, housing higher number of families in lesser space. A building is consider a high-rise building as a building is taller than 75 feets (23 meters) in height measured from the lowest level of fire department vehicle access to the floor of the highest occupable storey by The National Fire Protection Association (NFPA, 2000). But from different point of view, a building is deemed a high-rise specified by the fire and building codes in the area in which the building is located (Craighead, 2003). But for the purpose of this research, high-rise buildings to be selected for study are those buildings taller than 75 feets or roughly buildings taller than seven storeys in height are categorized as a high-rise building. It can be use varies between residential, administrative or as a hotel. Generally, a high-rise structure is considered to be one that extends higher than the maximum reach of available fire-fighting equipment. In absolute numbers, this has been set variously between 75 feet (23 meters) and 100 feet (30 meters) (Knoke, 2006) or about seven to ten stories and it all depending on the slab-to-slab distance between floors.

2.4 Sky View Factor

The Sky View Factor has been commonly used to indicate the impact of urban geometry on air temperature differences in cities. The Sky View Factor indicates the ratio of the radiation received (or emitted) by a planar surface from the sky to the radiation emitted (or received) from the entire hemispheric radiating environment (Watson and Johnson, 1987) as shown in Figure 2.2. Owing to its important role in radiation balance schemes, SVF has been widely used by climatologists to investigate the relationships between urban geometry and nocturnal urban heat intensity (Unger, 2004). The Sky View Factor is a dimensionless value between 0 and 1 and approaches unity in perfectly flat terrain, whereas locations with obstructions such as buildings and trees will cause the Sky View Factor to decrease proportionally (Oke, 1993).

The Sky View Factor is a measure of the openness of the sky to radiative transport in relation to a specific location, where a value of 0 (complete obstruction) means that all outgoing radiation will be intercepted by obstacles and a value of 1 (no obstruction) means that all radiation will propagate freely to the sky (Brown *et al*., 2001).

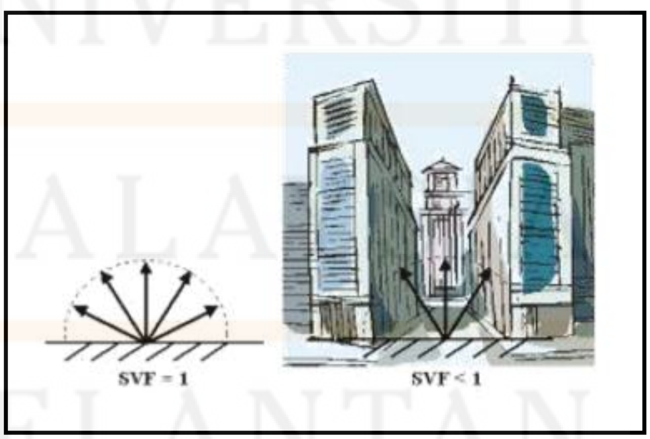


Figure 2.2: Illustrative definition of the concept of Sky View Factor (Source: Rezaei and Rafieian, 2014).

2.5 RayMan 1.2 Application

The RayMan, which has been developed for urban climate studies, has a broader use in applied climatology (Matzarakis *et al*. 2004; Lin and Matzarakis, 2008). It also includes, outputs, such as sunshine duration and shadow, can assist in the design and planning of recreation areas and the design of urban structures.

When using the computer software Ray- Man 1.2 Application, an input window for urban structures (buildings, deciduous and coniferous trees) comes up as shown in Figure 2.3. The opportunity of free drawing and output of the horizon (natural or artificial) are included for the estimation of sky view factors as shown in Figure 2.4. The implementation of fish-eye- photographs for the calculation of sky view factors is also possible. The amount of clouds covering the sky can be included by free drawing, while their impact on the radiation fluxes can be estimated (Matzarakis 2001).

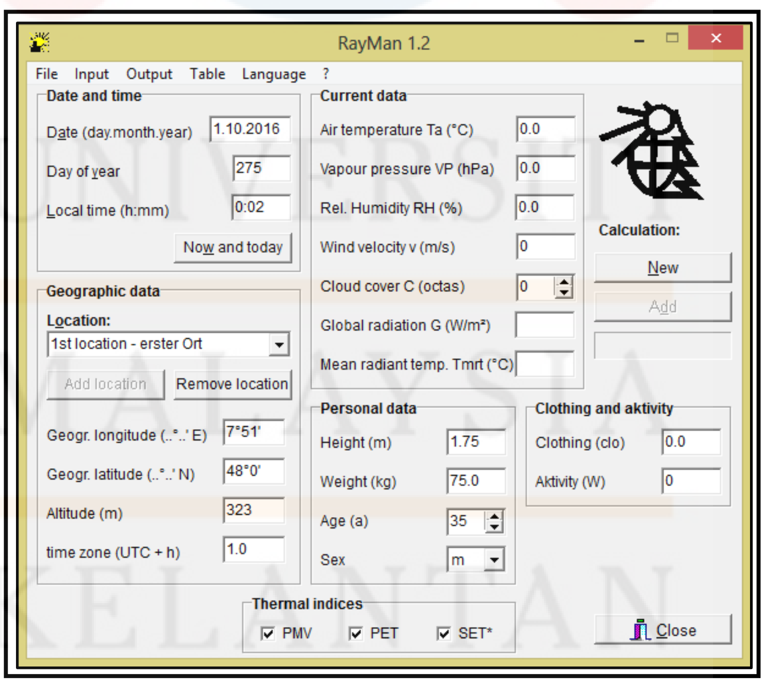


Figure 2.3: The main window of RayMan 1.2.

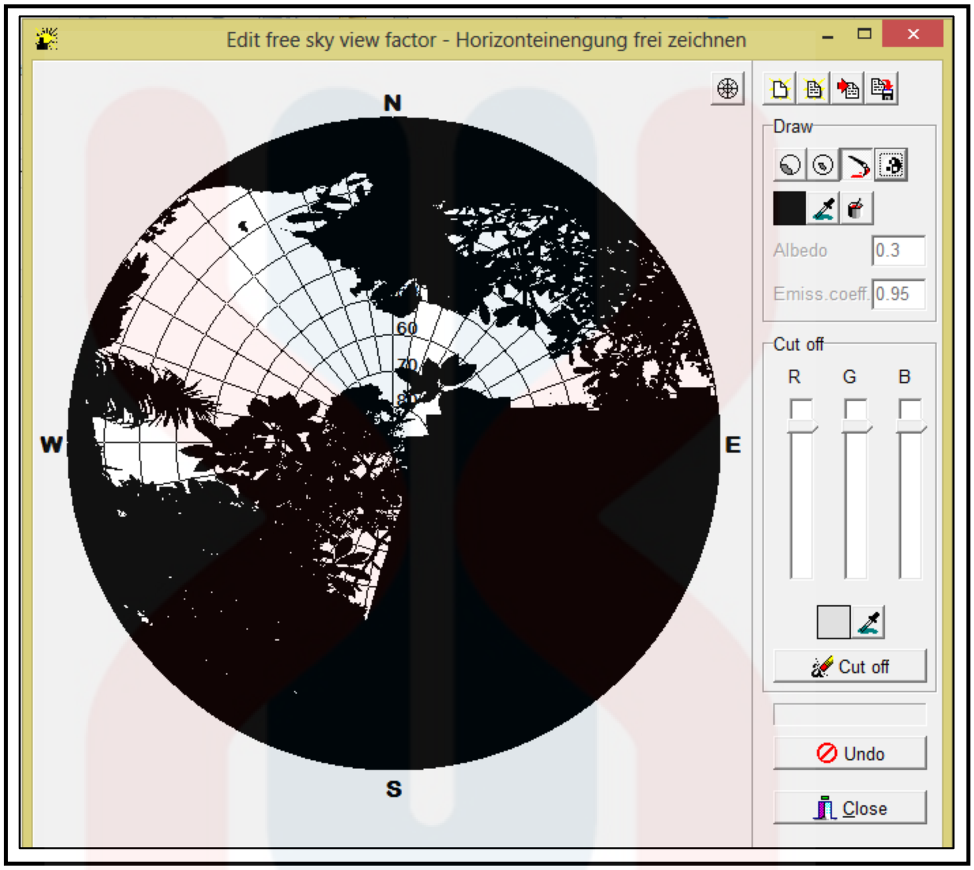


Figure 2.4: Example of calculation of sky view factor input.

CHAPTER 3

MATERIALS AND METHODS

3.1 Study Area

The study was executed in Kota Bharu (Jalan Hamzah, Jalan Mahmood and Jalan Bayam) which is the city center of Kelantan. Over the past decades, Kota Bharu had underwent a rapid development particularly the constructions of the high rise buildings. The area of this study consist of a radius of high rise non-green buildings namely Perdana Hotel (Figure 3.1), Wisma Persekutuan Kelantan (Figure 3.2), KPJ Perdana Specialist Hospital (Figure 3.3), Hospital Raja Perempuan Zainab II (Figure 3.4), Kelantan Trade Centre (Figure 3.5) and Ibu Pejabat Polis Kontinjen Kelantan (Figure 3.6). Together with these building images, a table consisting of general information of the buildings were provided. Table 3.1 until 3.6 represent the six buildings respectively. The study area can be represent in Google Maps (2010) which is shown in Figure 3.7.

3.1.1 Perdana Hotel

Perdana Hotel Perdana Hotel was located at Jalan Mahmood, 15200 Kota Bharu, Kelatan. This white and nude brown coloured building was owed by Perbangunan Nasional Berhad (PNB). Figure 3.1 shows the visual of the building. Perdana Hotel had been established for decades but since March 2013, a new allotment of 12 storeys building was added. This commercial building was 80 metres high and has the area of 243 665 square/ feet. Table 3.1 had the summarized general information of Perdana Hotel.

Figure 3.1: Image of Perdana Hotel.

Table 3.1: General Information of Perdana Hotel.

Title	Description
Name of building	Hotel Perdana Kota Bharu
Owner	Perbangunan Nasional Berhad (PNB)
Address	Jalan Mahmood, 15200 Kota Bharu, Kelantan, Malaysia
Number of Storey	12 storeys
Function of Building	Commercial
Height	80 metres
Area	243 665 square/feet
Age	3 years old (Since march 2013)
Colour	White, nude brown

3.1.2 Wisma Persekutuan Kelantan

Wisma Persekutuan Kelantan was located at Jalan Bayam, 15200 Kota Bharu, Kelantan and functioned as an administrative building. This building was owned by Jabatan Perdana Menteri and had operated since July 1979. Wisma Persekutuan Kelantan has 13 storeys with total height of 132 feets and an area of 155 809.97 square/ feet. The building can be identified with its colour of white and yellow. Figure 3.2 shows the visual of the building while Table 3.2 summarised the general information of the building.

Figure 3.2: Image of Wisma Persekutuan Kelantan.

Table 3.2: General Information of Wisma Persekutuan Kelantan.

Title	Description
Name of building	Wisma Persekutuan Kota Bharu
Owner	Jabatan Perdana Menteri
Address	Jalan Bayam, 15200 Kota Bharu, Kelantan
Number of Storey	13 storeys
Function of Building	Administrative
Height	132 feet
Area	155 809.97 square/feet
Age	37 years old (Since July 1979)
Color	White, yellow

3.1.3 KPJ Perdana Specialist Hospital

KPJ Perdana Specialist Hospital was located at Lot PT 37 & 600, Seksyen 14, Jalan Bayam, Kota Bharu, 15200, Kelantan. This white, red and blue colored building was owed by Kumpulan Pakar Johor. Figure 3.3 shows the visual of the building. KJP Perdana Specialist Hospital had been established since March 2013. This facility building was 84 feet high and has the area of 143 836 square/ feet. Table 3.3 had the summarized general information of KPJ Perdana Specialist Hospital.

Figure 3.3: Image of KPJ Perdana Specialist Hospital.

Table 3.3: General Information of KPJ Perdana Specialist Hospital.

Title	Description
Name of building	KPJ Perdana Specialist Hospital
Owner	Kumpulan Pakar Johor
Address	Lot PT 37 & 600, Seksyen 14, Jalan Bayam, Kota Bharu, 15200, Kelantan, Malaysia
Number of Storey	7 storeys
Function of Building	Facility
Height	84 feet
Area	143 836 square/feet
Age	3 years old (Since march 2013)
Color	White, red, blue

3.1.4 Kelantan Trade Centre

Kelantan Trade Centre was located at Lot 684, Seksyen 14, Jalan Bayam, 15200 Kota Bharu. Perbadanan Pengurusan Kelantan Trade Centre owned this building and had operated since 2008. Kelantan Trade Centre had 19 storeys with total height of 171 feet making it highest building in the study area. This residential building had an area of 9494.40 square/ feet and can be identified with its color of cream and nude brown. Figure 3.4 shows the visual of the building while Table 3.4 summarized the general information of the building.

Figure 3.4: Image of Kelantan Trade Centre.

Table 3.4: General Information of Kelantan Trade Centre.

Title	Description
Name of building	Kelantan Trade Centre (Apartment Tower)
Owner	Perbadanan Pengurusan (MC) Kelantan Trade Centre
Address	Lot 684, Seksyen 14, Jalan Bayam, 15200 Kota Bharu, Kelantan, Malaysia
Number of Storey	19 storeys
Function of Building	Residential
Height	171 feet
Area	9494.40 square/feet
Age	8 years old (Since 2008)
Color	Cream, nude brown

3.1.5 Ibu Pejabat Polis Kontinjen Kelantan

Ibu Pejabat Polis Kontinjen Kelantan was located at Jalan Bayam, 15200 Kota Bharu, Kelantan. This blue and white colored building was owed by Malaysian Government. Figure 3.5 shows the visual of the building. Ibu Pejabat Polis Kontinjen Kelantan had been established since March 1979. This administrative building was 122 feet high and has the area of 155 809.97 square/ feet. Table 3.5 had the summarized general information of Ibu Pejabat Polis Kontinjen Kelantan.

Figure 3.5: Image of Ibu Pejabat Polis Kontinjen Kelantan.

Table 3.5: General Information of Ibu Pejabat Polis Kontinjen Kelantan.

Title	**Description**
Name of building	Ibu Pejabat Polis Kontinjen Kelantan
Owner	Malaysian Government
Address	Jalan Bayam, 15200 Kota Bharu, Kelantan, Malaysia
Number of Storey	11 storeys
Function of Building	Administrative
Height	122 feet
Area	155 809.97 square/feet
Age	37 years old (Since 1979)
Color	Blue, white

3.1.6 Hospital Raja Perempuan Zainab II

Hospital Raja Perempuan Zainab II was located at Jalan Hospital Kota Bharu, Kelantan 15000 Kota Bharu Kelantan. This white colored building was owed by Kementerian Kesihatan Malaysia. Figure 3.6 shows the visual of the building. Hospital Raja Perempuan Zainab II had been established for decades but since March 2013, this new allotment of 9 storeys building was added. This facility building was 86 meters high and has the area of 243 665 square/ feet. Table 3.6 had the summarized general information of Hospital Raja Perempuan Zainab II.

Figure 3.6: Image of Hospital Raja Perempuan Zainab II.

Table 3.6: General Information of Hospital Raja Perempuan Zainab II.

Title	Description
Name of building	Hospital Raja Perempuan Zainab II
Owner	Kementerian Kesihatan Malaysia
Address	Jalan Hospital Kota Bharu, Kelantan 15000 Kota Bharu Kelantan, Malaysia
Number of Storey	8 storeys
Function of Building	Facility
Height	86 meters
Area	243 665 square/feet
Age	3 years old (Since march 2013)
Color	White

Figure 3.7: Google earth image representative of the study area and the buildings involved. (Source: google)

3.2 Data Collection Method

Sky View Factor is one of the essential aspects related to pollution, temperature variations, heat island, and several other environmental specifications. Sky View Factor is a value that is dimensionless set between 0 and 1 and approaches merge in perfectly flat topography, whereas region with interferences such as buildings and trees will cause the Sky View Factor to decrease proportionally (Oke, 1993). The Sky View Factor measures the openness of the sky to radiative transport in relation to a specific location, where a value of 0 which is equivalent to complete obstruction means that all outgoing radiation will be intercepted by obstacles and a value of 1 which is equivalent to no obstruction means that all radiation will propagated freely to the sky (*Brown et al*., 2001). One of common technique for measuring SVF in urban environments is photographical (Unger, 2004).

Urban heat was contributed by rapid development in the area and other anthropogenic activities that caused heat to accumulate in dense area thus making the temperature to be high. To prove this, secondary data and primary data had been collected. Backdated temperature data were acquired from Malaysia Meteorology Department for year 2012, 2013, 2014, 2015 and 2016 as the secondary data. While the primary data were collected from site visit to the study area on 16th August until 22nd August 2016.

3.2.1 Photographical Method

Fish-eye photographs were taken at ground level with a digital camera together with a detachable 180' fish-eye lens. To abstain the photographer appearing on the images, the ground-level fish-eye photographs were taken with a timer. The camera was attached to a tripod and the picture was taken from its height above the surface at each of the selected points. As reference points, edges of the surrounding buildings were used.

Since no elevation standard for capturing Sky View Factor imagery had been established (Svensson, 2004), the pictures were taken vertically at the same tripod height in an attempt to ensure consistency. The photographs were collected between 11.00 am till 2.00 pm under clear blue skies.

The photographs from the camera taken by the fish-eye lens was analyzed and scanned to create digital images. The scanned images were then converted from color to black and white. The black color represented ground, buildings and vegetation whilst white represented the sky. This conversion was done by altering the brightness and contrast of each image. It relied on the sky conditions and the existence of cloud, direct sun, obstructions and the amount of vegetation and buildings in the image.

Images taken under constant sky conditions which was clear with no direct sun were usually the simplest to analyze consistently and accurately. When scattered clouds appear in an image, particularly near the horizon, the clouds often appeared as dark as buildings or vegetation in the image, which makes it difficult to set appropriate brightness values to discriminate terrain and sky. When the sun appeared in an image it causes particular problems for the analysis of vegetation, as it tends to wash out branches and tree trunks in the image.

In these fish-eyed photos, the hemispheric environment was projected onto a circular plane. After processing the photos and identifying the skyline, Sky View Factor was estimated by calculating the share of the visible sky (Chen *at. al.*, 2012; Grimmond *at. al.*, 2001). The Sky View Factor calculation was done using RayMan 1.2 application. The application was user-friendly and free for academic use. The fish-eye image were imported and edited so that it become black and white with black being the obstacle and the white represent the clear sky. After calculating, the application will came out an output of Sky View Factor value.

3.2.2 Trend Analysis

In this research study, trend analysis method was used to evaluate the trend of backdated data and current data. Trend analysis was a technique of observing an underlying pattern of behavior over extended period of time. In order to identify the potential charges of probability distribution changed over time (George & William, 1989)

For the recent data, samples had been collected from six high rise non-green buildings located in the center of Kota Bharu. Temperature reading had been recorded for a week in between the time of 11 am until 2 pm. This period is ideal because the sun is located directly above the buildings at these hours making it the peaked highlight in the day. The readings were achieved from direct sunlight directed towards the rooftop floor using a thermometer. The thermometer frame case were hold horizontally and the reading was recorded after the indicator in the thermometer stabilized.

For the backdated data, the readings was obtained from Malaysia Meteorology Department which was stationed in Kota Bharu. The data were obtained was daily temperature reading for five years (2012, 2013, 2014, 2015 and 2016 (until September)).

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Trend Analysis

The trend analysis was analyzed based on backdated data and current data. The current data was achieved by daily temperature recorded in a week. Temperature was taken on the top of six buildings during noon (in between 11 am to 2 pm). The data was then analyzed and compared to backdated data received from Malaysia Meteorological Department in order to understand the trend analysis of temperature. The backdated data was taken from year 2012 to (September) 2016, which was obtained from Meteorology station in Kota Bharu with latitude of N 6° 10', longitude of E 102° 18' and elevation of 4.4 m. The trend results provide a general idea of any changes noticeable between the backdated data and current data collected.

4.1.1 Trend Analysis on Backdated Data of Daily Temperature

Temperature is one of the most important elements in urban heat determination. Thus, temperature trends able to provide critical evidence for evaluation and observation of the effects of the development towards urban heat. Figure 4.1 shows the graph of daily temperature from year 2012 until (September) 2016 taken from Meteorology Department Malaysia stationed in Kota Bharu. The trends show different pattern each year.

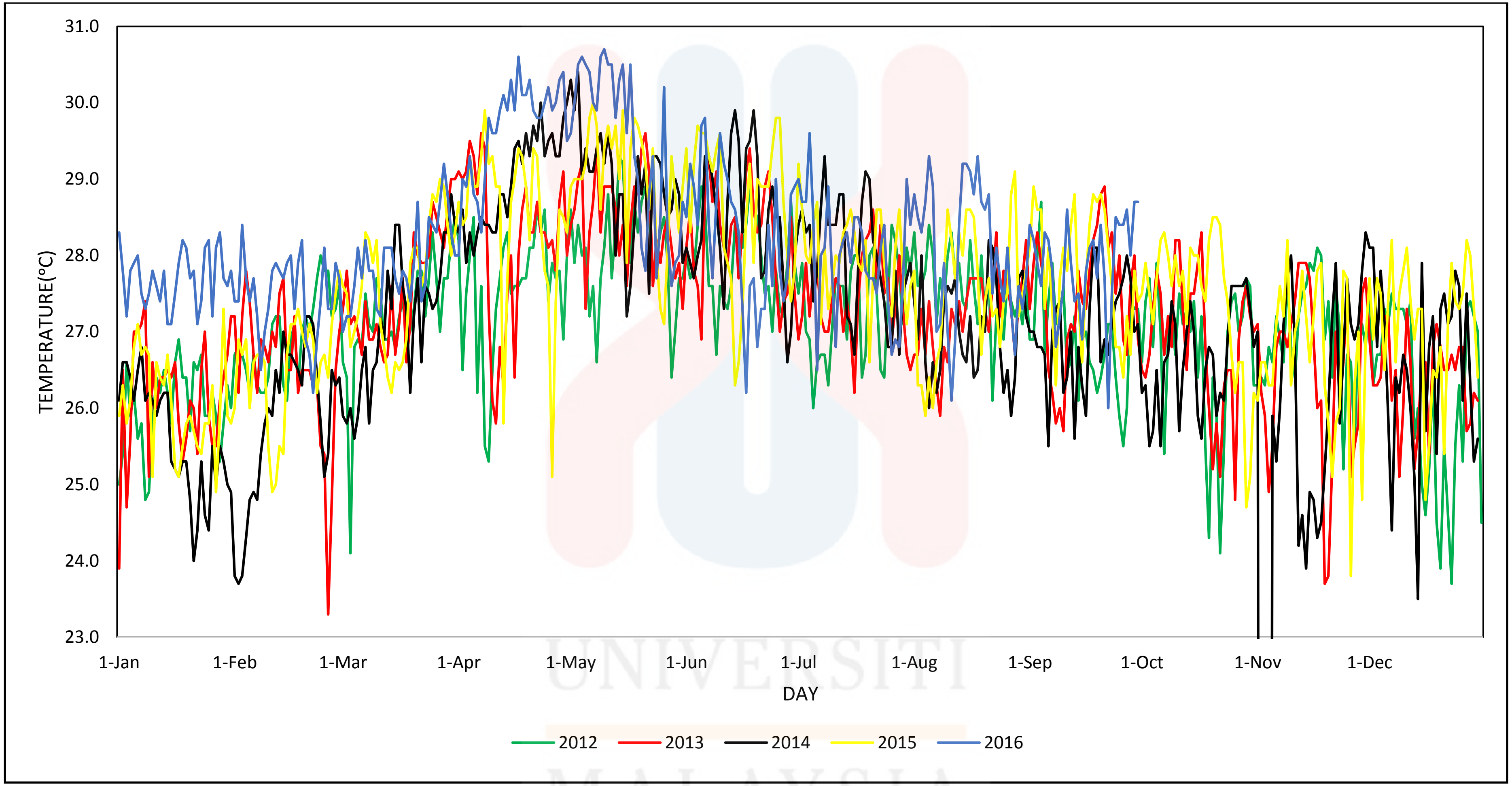


Figure 4.1: Graphical representation of historical data.

The trends show inconsistent change for every year, which include the defective values that were recorded. From the data received from Malaysia Meteorology Department, there had been defective values on 3rd till 5th November 2014 which effect the overall trend. Aside from the defective values, the trend shows that the lowest temperature reading was on 26th February 2013 with 23.3 ^{o}C. The highest temperature reading was on 10th May 2016 with 30.7 ^{o}C.

Based on Figure 4.1, it shows that the backdated data were inconsistent. This is because the temperature reading were affected by monsoon seasons. Kota Bharu experience South West monsoon season from late May to September, signifies relatively dry weather. Therefore, the daily temperature reading shows that the trend of temperature peaks during these period. The highest temperature reading was on 10th May 2016 with 30.7 ^{o}C.

On the other hand, Kota Bharu experience North East Monsoon from November to March, which bring heavy rainfall and humid weather. The trends starts to incline and the lowest temperature reading were on 26th February 2013 with 23.3 ^{o}C.

4.1.2 Trend Analysis on Recent Data of Daily Temperature

This trend analysis were achieved by data recorded on each rooftop of these buildings located midtown Kota Bharu from the time of 11 am to 2 pm. There are six high rise non-green buildings within the study area. The data was recorded consistently for seven days. Table 4.1 and Figure 4.2 represent the data obtained.

Table 4.1: Recent temperature reading acquire from site visits.

	DAY						
	1	2	3	4	5	6	7
Wisma Persekutuan Kelantan	31 °C	31°C	33°C	36°C	37°C	37°C	35°C
KPJ Specialist Hospital	35°C	32°C	33°C	36°C	37°C	39°C	37°C
Kelantan Trade Centre	36°C	36°C	33°C	34°C	37°C	42°C	39°C
Perdana Hotel	36°C	34°C	34°C	35°C	40°C	37°C	39°C
Ibu Pejabat Polis Kontinjen Kelantan	33°C	35°C	33°C	30°C	35°C	34°C	34°C
Hospital Sultanah Zainab II	31°C	35°C	33°C	32°C	35°C	33°C	33°C

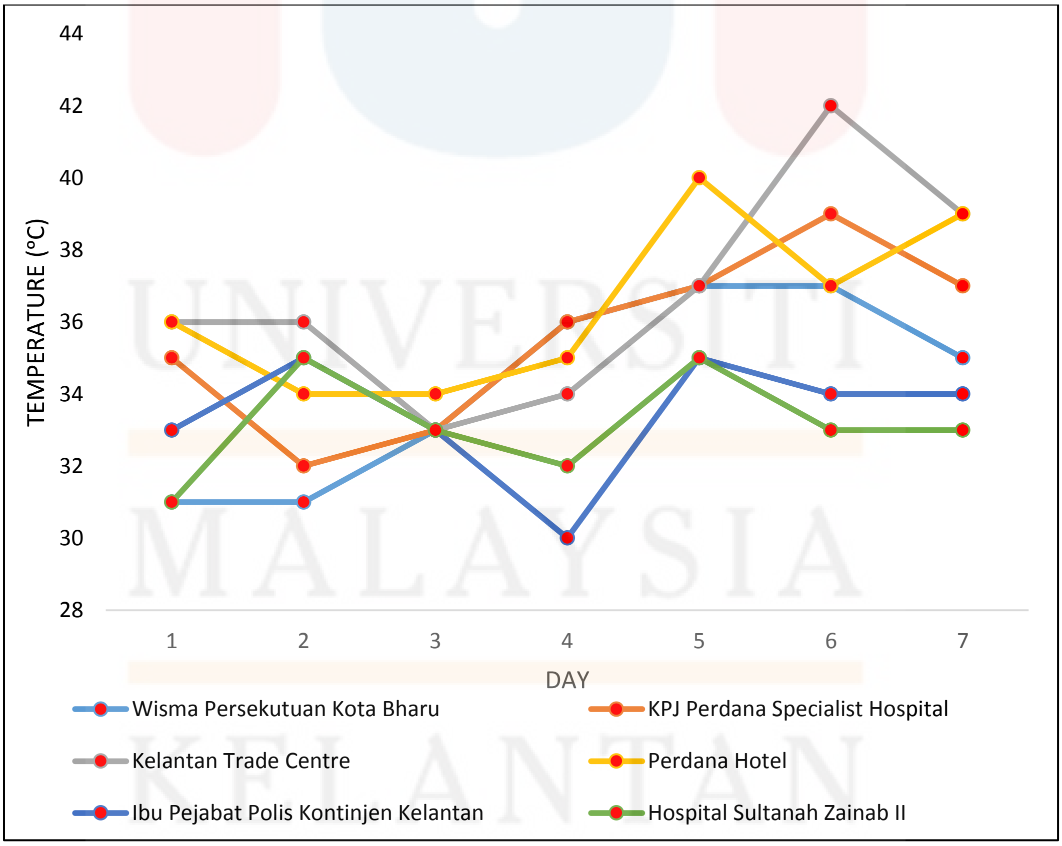


Figure 4.2: Trend analysis on recent daily temperature in a week.

For Wisma Persekutuan Kota Bharu, the data recorded starts with 31 ^{o}C on the first day and also on the second day. The temperature were the highest on the fifth and sixth day with 37 ^{o}C. the last day recorded a drop in temperature from the previous day with 35 ^{o}C.

Comparing to the other buildings, KPJ Perdana Specialist Hospital were a lot less high with only seven floors being the highest point. The first day recorded a reading of 35^{o}C and decreasing for second with 32 ^{o}C. On the third day, the temperature increase with 33 ^{o}C and continue to incline until the sixth day with the highest reading of 39 ^{o}C. The temperature for the seventh day was recorded with 37 ^{o}C.

Kelantan Trade Center was the highest building in the study area with a total of nineteen floors. The temperature on the first day was 36 ^{o}C. The temperature reading remain the same on the second day but drop to 33 ^{o}C on day three. For the fourth and fifth day, the temperature increase until it peaked on the sixth day with 42 ^{o}C. for the last day, the reading recorded was 39 ^{o}C.

For Perdana Hotel, I climbed up twelfth floor and manage to get 36 ^{o}C on the first day. The reading for the second and the third day were the same with 34 ^{o}C. there were an escalation on the fourth day and reach apex on the fifth day with 40 ^{o}C. The temperature on day six was 37 ^{o}C followed with 39 ^{o}C on day seven.

For Ibu Pejabat Polis Kontinjen Kelantan, the data recorded starts with 33 ^{o}C. The temperature were recorded as the highest on the second day and fifth day with 35 ^{o}C. While the lowest were on the fourth day with 30 ^{o}C. The rest of the days were average between 33 ^{o}C and 34 ^{o}C.

The last building which is the Hospital Sultanah Zainab II has the lowest temperature reading on the first day with 31 °C. While the highest were on the second and fifth day with 35 °C. The third, sixth and seven day has the same reading of 33 °C.

Different from the backdated data, recent data were only achieved in a week. The data were taken from 16th August 2016 until 22nd August 2016 at noon. The temperature were taken from the top of six high rise buildings placed near of each other. Tall and packed buildings contribute to the complex exchange between buildings and the screening of the skyline which causes urban heat (Oke *et al.*, 1991). This was proven when the highest temperature recorded was 41°C at Kelantan Trade Center with the height of 171 feets tall located in between KPJ Perdana Specialist Hospital and Hotel Perdana.

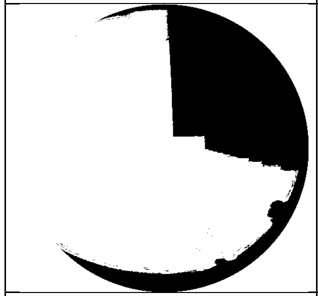
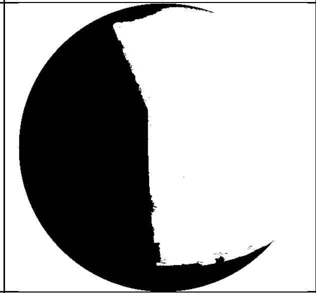
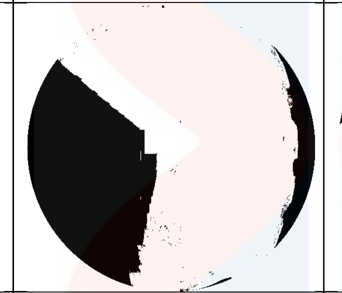
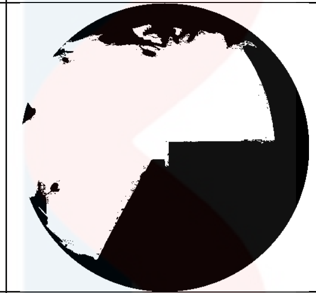
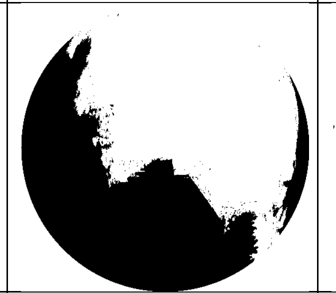
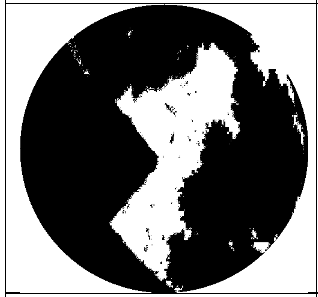
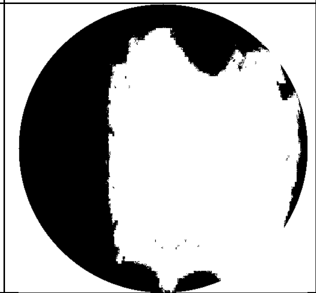
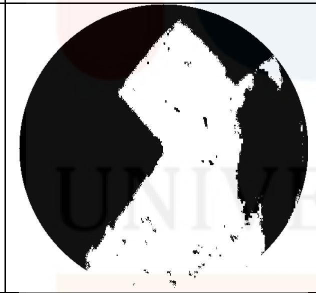
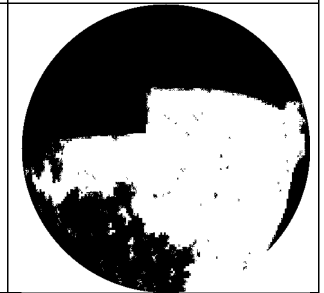
All six buildings were not recognized as green building because the materials used were not equipped to adapt buildings to the Malaysia climate, culture and environment. This affect the urban heat phenomenon because the thermal properties of materials, can increase storage of sensible heat in the fabric of the city (Oke *et al.*, 1991).

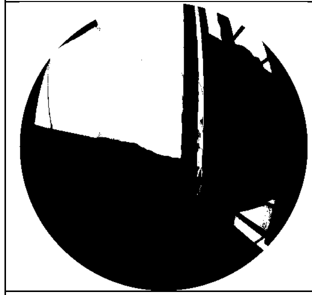
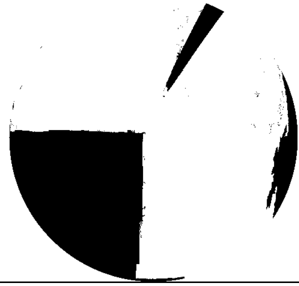
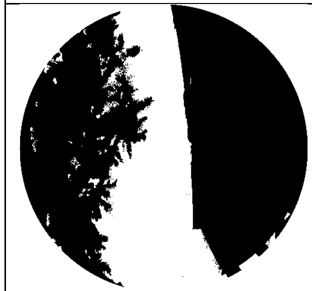
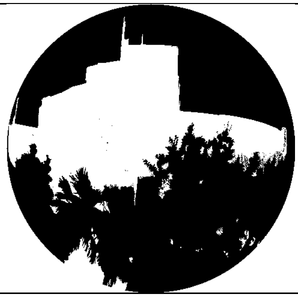
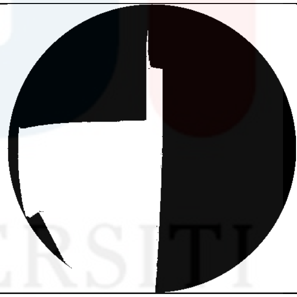
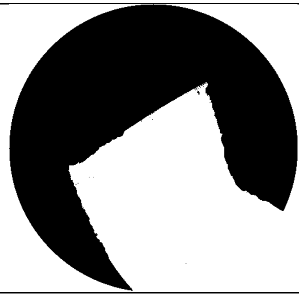
4.2 Sky View Factor: Photographical Method

This method introduce data that were recorded by photographical method and process through an application for Sky View Factor calculation. RayMan 1.2 application is a user friendly application enabling to compute the Sky View Factor values directly from photos taken by digital camera with fish-eye lens. Fish-eye images were taken from each buildings' edges. Sky View Factor is the amount of sky visible when viewed from the ground up.

Sky View Factor is a dimensionless value that ranges from 0 to 1 being from entirely visible sky to entirely canopied sky respectively. This method resulted in Sky View Factor value that was affected by the sky visibility. Figure 4.3 shows the graph of Sky View Factor for each point from six different buildings in midtown Kota Bharu. The statistics shows different Sky View Factor values based on the photographs taken at each point.

Table 4.2: Sky View Factor (SVF) reading through photographical analysis.

Wisma Persekutuan Kota Bharu					
Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
					
SVF= 0. 694	SVF= 0.556	SVF=0.676	SVF= 0.524	SVF= 0.563	SVF=0.680
KPJ Perdana Specialist Hospital					
Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
					
SVF= 0.242	SVF= 0.620	SVF=0.455	SVF= 0.570	SVF= 0.482	SVF= 0.489

Kelantan Trade Centre					
Point 1	Point 2	Point 3	Point 4	Point 5	
					
SVF= 0.305	SVF= 0.729	SVF= 0.494	SVF= 0.516	SVF= 0.723	
Perdana Hotel					
Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
					
SVF= 0.0.345	SVF= 0.349	SVF= 0.611	SVF= 0.335	SVF= 0.425	SVF= 0.575

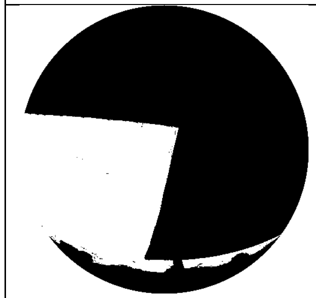
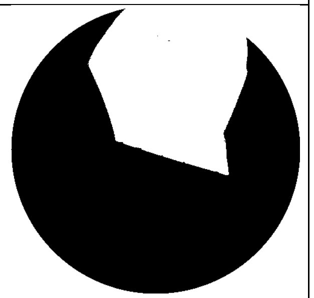
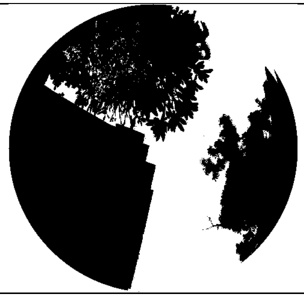
Ibu Pejabat Polis Kontinjen Kelantan					
Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
					
SVF= 0.324	SVF=0. 382	SVF= 0.501	SVF= 0.530	SVF= 0.533	SVF= 0.316
Hospital Sultanah Zainab II					
Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
					
SVF= 0.172	SVF= 0.318	SVF= 0.483	SVF= 0.167	SVF= 0.072	SVF= 0.249

Table 4.3: Sky View Factor calculated at different point.

	Sky View Factor						Mean
	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	
Wisma Persekutuan Kota Bharu	0.694	0.556	0.676	0.524	0.563	0.680	0.616
Kpj Specialist Hospital	0.242	0.620	0.455	0.570	0.482	0.489	0.476
Kelantan Trade Center	0.305	0.729	0.494	0.516	0.723		0.553
Perdana Hotel	0.345	0.349	0.611	0.335	0.425	0.575	0.44
Ibu Pejabat Polis Kontinjen Kelantan	0.324	0.382	0.501	0.530	0.533	0.316	0.378
Hospital Sultanah Zainab Ii	0.172	0.318	0.483	0.167	0.072	0.249	0.244

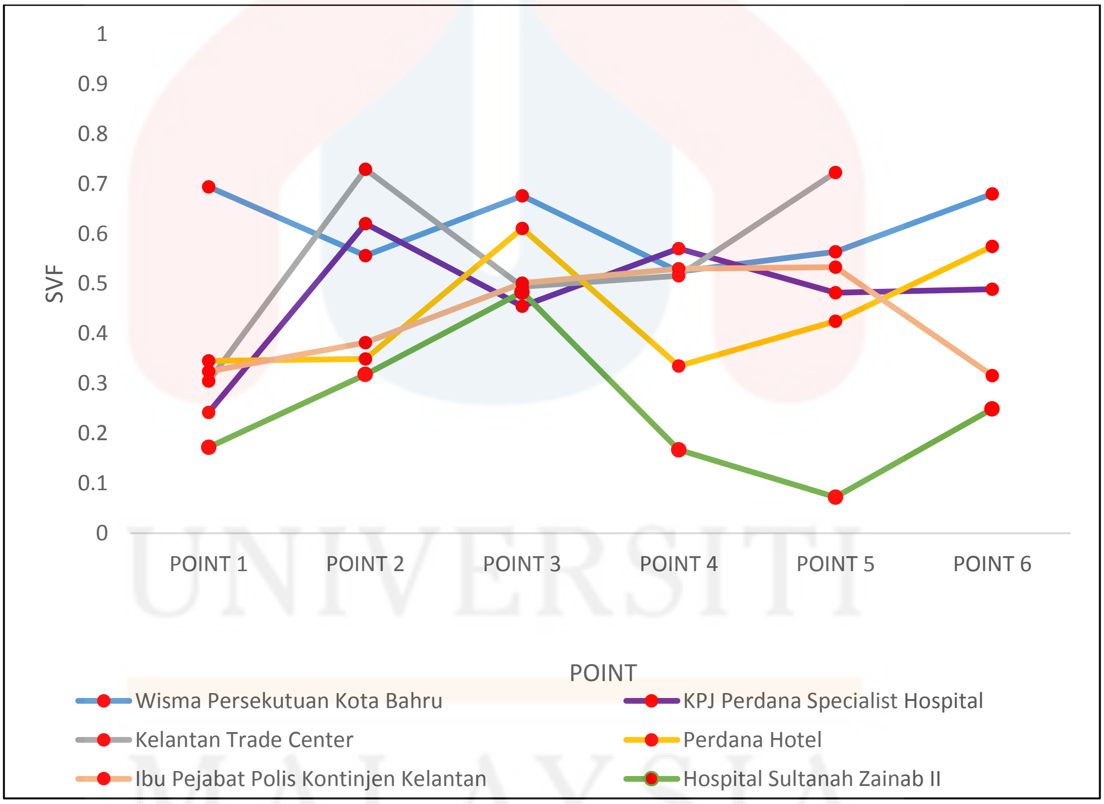


Figure 4.3: Sky View Factor on each point.

From the photographic analysis shown in Table 4.2, the white represent sky visibility. Thus, the higher the white area, the higher the Sky View Factor percentage. Sky View Factor calculated at different point in Table 4.3 showed that the highest Sky View Factor value were on point 2 of Kelantan Trade Center with 0.729 and the lowest with 0.072 on point 5 at Hospital Sultanah Zainab II.

Wisma Persekutuan Kota Bharu carries the average Sky View Factor value of 0.616. The lowest Sky View Factor value record were 0.524 at point 4 while the highest were 0.694 at point 1. The surrounding area of Wisma Persekutuan Kota Bharu had limited trees. There were an open parking lot at throughout it sides and Hospital Sultanah Zainab II was located closely behind it.

The second building, KPJ Specialist Hospital has the average Sky View Factor value of 0.476 which was considered low compared the other buildings. The sky visible were interfered with trees, the neighboring buildings and the building itself. The lowest Sky View Factor value was 0.242 at point 1 while the highest was 0.620 at point 2.

Kelantan Trade Center has the average Sky View Factor value of 0.533. The highest Sky View Factor reading was 0.729 at point 2 while the lowest wat at 0.305 at point 1. This building is the highest among the other buildings and it was located closely next to KPJ Perdana Specialist Hospital. There were hardly any vegetation near the building.

Perdana Hotel is an establishment providing accommodations, meals, and other services for travelers and tourists. Thus, the surrounding was beautify with big trees and a lot of decorative vegetation. The highest Sky View Factor value was 0.611 at point 3 and the lowest was 0.335 at point 4. There were open parking lots at it sides which allow sky to be detectable.

Ibu Pejabat Polis Kontinjen Kelantan had the average Sky View Factor value with 0.378. The lowest Sky View Factor value was 0.316 at point 6 and the highest value was 0.533 at point 5. This building has a few big trees surrounding the area. There was a large open space around it for assemblies.

Hospital Sultanah Zainab II has the lowest average Sky View Factor value of 0.244. The highest Sky View Factor value was 0.483 at point 3 and the lowest Sky View Factor value was 0.072 at point 5. Hospital Sultanah Zainab II has a lot of vegetation surrounding it. There were also a lot of less higher buildings surrounding the designated building.

The Sky View Factor values were achieved by taking fish-eye photograph of the buildings' canyons and import a black and white version of the photographs into RayMan 1.2 Application. The application will then automatically calculate the Sky View Factor value. The application detect the differences between the sky and the obstacle as white and black respectively.

High Sky View Factor value indicates the ratio of the radiation received by a planar surface from the sky to the radiation emitted from the entire hemispheric radiating environment were also high. (Watson and Johnson, 1987). Thus, contributing to urban heat.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This research was done in order to evaluate the effect of the high rise non-green building in the urban area by calculating the Sky View Factor of the non-green buildings and to evaluate the trends of the temperature by comparing the current data with the backdated data of Kota Bahru, Kelantan. The objectives of the thesis had been achieved. The results obtained was concluded and discussed in this chapter.

Overall, the research study can be concluded with the Sky View Factor reading of the non-green buildings that had been achieved by photographical method. Fish-eye images were processed through an application called RayMan 1.2. The results matched the expected outcome.

Based on my observation, the surrounding of the building with low Sky View Factor value had lots of big trees and was not only used as shades but also beautify the area. There were buildings that had big trees surrounding it making it a lot greener to the eyes like Hospital Sultanah Zainab II.

The distance between the buildings were also close. The buildings were only separated by a road or parking lots which made the area dense and packed. Packed and tall buildings cause the Sky View Factor value to be low as the visibility of the sky was limited and also a major contribution towards urban heat phenomenon.

The urban heat in Kota Bharu had also been compared between backdated data acquired from Malaysia Meteorology Department and recent data primary data acquired during site visit. These two data were analyzed through trend analysis.

In conclusion, the two trend analysis were distinguished and it shows a highly difference in temperature readings. The recent data readings were a lot higher than the backdated data readings. Thus, proving that Kota Bharu is experiencing urban heat phenomenon. For some of the buildings, there were hardly any big size trees around in example of Wisma Persekutuan Kota Bharu and Kelantan Trade Centre while the neighboring buildings were closed by. This factor also contributing to urban heat phenomenon.

From the recent data, the highest temperature reading was 42 ^{o}C. Considers that the record obtained from the nineteenth floor, the temperature recorded on the ground was different. This may possess health hazardous effect on human being by virtue of enzyme denaturation will occur once the temperature exceeding the optimum 40^{o}C. The optimum temperature of a human body ranges from 32°C to 37°C.

One of the main ways heat kills is by limiting the body's ability to regulate its own temperature. When body temperature rises, more blood flows to the skin and human sweats to dissipate body heat. If the ambient temperature is too high, those mechanisms can't cool the body efficiently and may even work to warm the body further. Adverse weather conditions like high humidity magnify that effect by reducing cardiovascular efficiency.

5.2 Recommendations

Based on the two objective that had been achieved, it shows urban heat is greatly affecting Kota Bharu. Thus, the knowledge and practice of urban heat mitigation are an important matter need to be focus on. These are following recommendation that can be followed in order to mitigate urban heat effects:

5.2.1 Green Roof

Green roofs reduce the amount of heat transferred from the roof to the inside of building as result of evapotranspiration and the shade created by the plants. They also cool the outside ambient air (McPherson, 1994) while extending the lifespan of the roof, due to the fact that green roofs provide protection from bad weather, exposure to UV radiation and temperature fluctuations, all factors which cause roof degradation (Déoux and Déoux, 2004; Oberndorfer *et al*., 2007). From the visits that I had made, most the high rise buildings had an open and flat rooftop accept for Perdana Hotel and Hospital Sultanah Zainab II. The open and flat rooftop can be inhibit by plants which can also contributing to the esthetic integration of buildings in the landscape.

5.2.2 Adding Vegetation around the Buildings

For optimal cooling, the vegetation planted around a building can protect the building from solar radiation. The texture and composition of the ground surrounding the building partially determine the inside and outside temperature of the building. Vegetation keeps the soil cooler and helps prevent direct, reflected and diffuse solar radiation that can affect cooling of the building (Akbari et al., 2001). In order to maximize the shade on a building, trees must be located on the east, southeast, southwest and west façades and, ideally, be large enough to shade all or part of the roof. Since the surrounding area majority of the buildings only have small potted plant, adding vegetation around the buildings are an ideal recommendation.

5.2.3 Government Support and Regulation

The government which also act as policy makers must take responsibility for establishing goals for the energy efficiency of building envelopes, both to the extent of new buildings construction and building backfits. Deployment of urban heat mitigation technologies is advised to be facilitated through innovative financing mechanism. Furthermore, building energy codes should also require technology installation that meets the latest standards emitting minimum contribution to urban heat.

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APPENDIX A

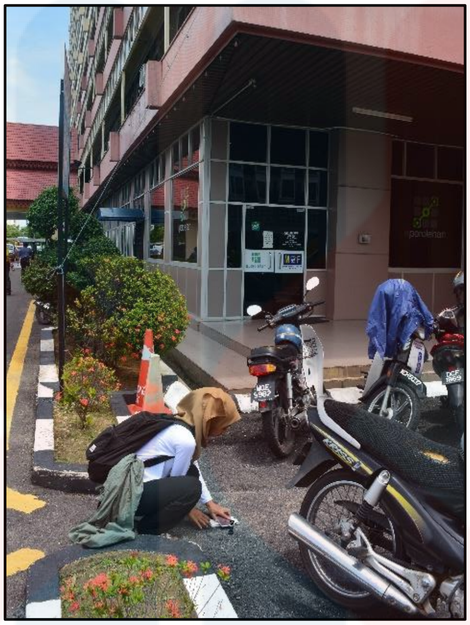

Figure A1: The figure shows how fish eye photograph were taken.

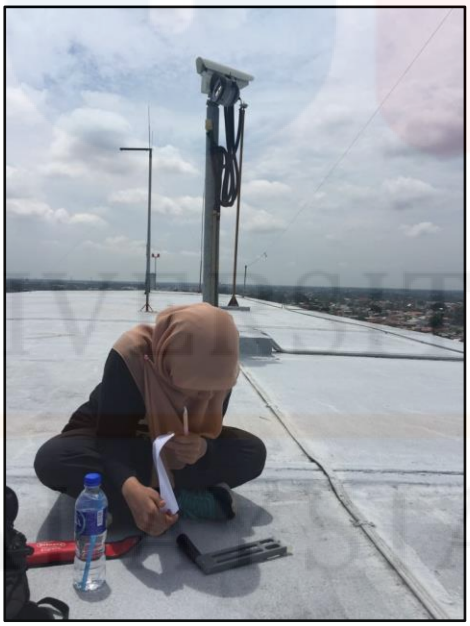

Figure A2: The figure shows how the temperature was taken.

Figure A3: The figure shows the works done at the study area.

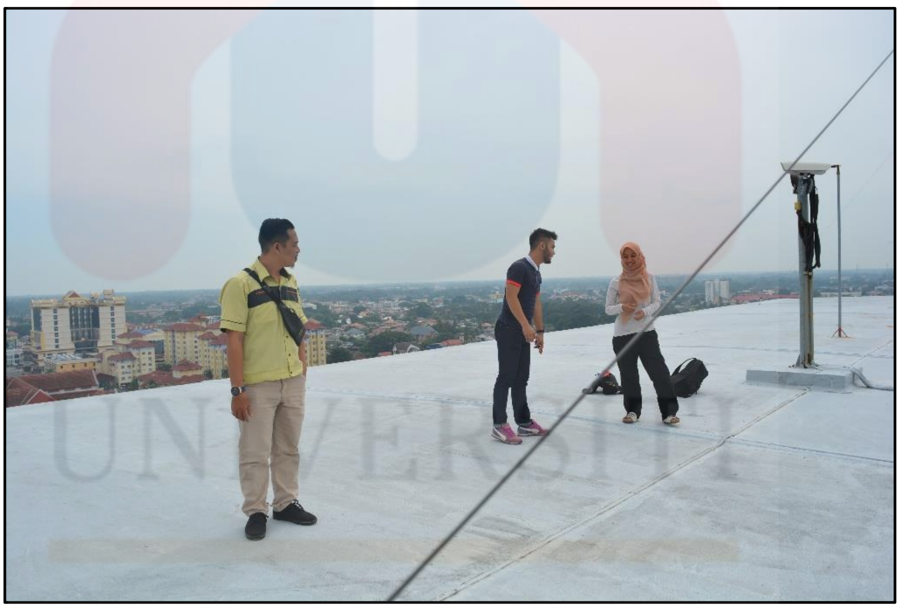

Figure A4: The escorts during the site visit to Wisma Persekutuan Kota Bharu.

Hotel.