



***THERMAL BIOCLIMATIC CONDITION OF DIFFERENT URBAN PARKS***

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**THERMAL BIOCLIMATIC CONDITION OF DIFFERENT URBAN PARKS**

By

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## **DEDICATION**

Thanks and Praise to Allah S.W.T for giving me the good health condition to finish this study.

This thesis is dedicated to:

### **My Parents,**

Nordin Bin Mohd Dagang and Noraida Binti Siman

### **My Siblings,**

Syaza Syazana, Amir'ul Asyraf, Muhammad Danial, Najwa Nur Azmina and Falyastothyunis

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### **My Supportive Supervisor,**

Dr. Ruzana Adibah Binti Mohd Sanusi

## ABSTRACT

Urban park provides many facilities and benefits that can be beneficial to urban citizens. Human thermal comfort in every urban park is important in order to make sure the user is thermally satisfied while using the urban park. However, different urban parks give different thermal satisfaction level because the tree compositions and arrangement at each of the urban park are different. Therefore, the objectives of this study were to investigate the influence of different types of park on human thermal comfort condition and to determine the relationships between human thermal comfort with tree characteristics. Three parks in Putrajaya were chosen as study area because of their distinct characteristics where Taman Saujana Hijau is a recreation vegetation type area, Taman Warisan Pertanian is an agriculture vegetation type area and Taman Rimba Alam is forest vegetation type area. Microclimate condition parameters of air temperature, relative humidity, wind speed, solar radiation and mean radiant temperature were measured and then used in Physiological Equivalent Temperature (PET) Index to estimate the human thermal comfort conditions. Tree characteristics such as height, canopy cover and canopy spread were also measured. This study found that different types of urban park significantly affected the human thermal comfort where PET was reduced up to 7°C (from strong heat stress to moderate heat stress) between Taman Rimba Alam with the other two parks. This is due to Taman Rimba Alam has more canopy coverage compared to Taman Saujana Hijau and Taman Warisan Pertanian. Moreover, there were significant relationship analyses between human thermal comfort and tree characteristics such as canopy cover, tree height and canopy spread. This shows that the tree characteristics and canopy coverage in park greatly influence the human thermal comfort. This study can help in the management and planning of urban park to improve the park thermal comfort conditions through consideration of the vegetation compositions and thermal conditions in an urban park.

## ABSTRAK

Taman dalam bandar menyediakan banyak kemudahan dan kelebihan yang boleh memberi kebaikan kepada masyarakat dibandar. Keselesaan haba manusia di setiap taman amat penting bagi memastikan kepuasan haba pengguna semasa menggunakan taman Bandar. Walaubagaimanapun, taman bandar yang berbeza memberikan tahap kepuasan haba berbeza kerana komposisi dan susunan pokok di setiap taman adalah berbeza. Oleh itu, objektif kajian ini adalah untuk mengkaji pengaruh taman yang mempunyai jenis berbeza terhadap keadaan keselesaan haba manusia dan untuk menentukan hubungan antara keselesaan haba manusia dan ciri-ciri pokok. Tiga taman di Putrajaya telah dipilih sebagai kawasan kajian disebabkan oleh ciri-ciri khasnya yang mana terdiri daripada Taman Saujana Hijau adalah kawasan jenis tumbuh-tumbuhan landskap (rekreasi), Taman Warisan Pertanian adalah kawasan jenis tumbuh-tumbuhan pertanian dan Taman Rimba Alam adalah kawasan jenis tumbuh-tumbuhan hutan. Parameter untuk keadaan mikroklimat seperti suhu udara, kelembapan relatif, kelajuan angin, radiasi solar, suhu purata radiant telah diukur dan digunakan untuk menganggarkan tahap keselesaan haba menggunakan indeks Physiological Equivalent Temperature (PET). Ciri-ciri pokok seperti litupan kanopi, ketinggian pokok dan kelebaran kanopi juga diukur. Kajian ini mendapati bahawa jenis taman bandar yang berbeza mempengaruhi tahap keselesaan haba manusia dimana nilai PET berkurang sehingga 7°C (daripada tekanan haba yang kuat kepada tekanan haba sederhana) antara Taman Rimba Alam dengan dua taman yang lain. Ini adalah kerana Taman Rimba Alam mempunyai mempunyai lebih banyak kawasan dilitupi kanopi berbanding Taman Saujana Hijau dan Taman Warisan Pertanian. Selain itu, terdapat analisis hubungan yang signifikan antara keselesaan haba manusia dan ciri-ciri pokok seperti litupan kanopi, ketinggian pokok dan kelebaran kanopi. Ini menunjukkan bahawa ciri-ciri pokok dan litupan kanopi dalam taman sangat mempengaruhi keselesaan haba manusia. Kajian ini dapat membantu dalam pengurusan dan perancangan taman dalam bandar untuk meningkatkan keadaan keselesaan haba dalam taman bandar melalui pertimbangan komposisi tumbuh-tumbuhan dan keadaan haba dalam taman bandar.

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## APPROVAL SHEET

I certify that this research project report entitled “Thermal Bioclimatic Condition of different urban parks” by Syaza Syahirah Binti Nordin has been examined and approved as a partial fulfilment of the requirements for the Degree of Bachelor of Forestry Science in the Faculty of Forestry, Universiti Putra Malaysia.

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## LIST OF ABBREVIATIONS

HTC	Human Thermal Comfort
GISS	Goddard Institute for Space Studies
WMO	World Meteorological Organizations
PMV	Predict Mean Vote
SET	Standard Equivalent Temperature
PET	Physiological equivalent temperature
ET	Equivalent Temperature
SPSS	Statistical Package of Social Science
ANOVA	Analysis Of Variance
LSD	Least Significance Different



# CHAPTER 1

## INTRODUCTION

### 1.1 General Background

Day by day, the development in urban area has grown rapidly in order to fulfil the people's demand such as housing area and roads. The development of urban areas can negatively impact the surrounding microclimate leads to the increase in high temperatures and urban heat waves events where can affect human health negatively like heat stroke (Koc et al., 2015). It also affects human activities where people choose to stay indoor when outside environment is hotter as the surrounding environmental condition can influence the human thermal comfort.

Human thermal comfort (HTC) is one of thermal bioclimatic conditions. HTC is not only depending on the air temperature but also the other microclimate factors such as mean radiant temperature, solar radiation, wind speed, relative humidity (Coutts et al., 2015) and physical factors such as topography of the area and climate of the area (Coccolo et al., 2018). In addition, human factors such as metabolism and clothing can also influence the HTC (Craenendonck et al., 2018). One of the strategies to enhance microclimate mitigation and improve thermal comfort in urban areas is with the use of green infrastructures like urban parks and street trees (Klemm, 2015; Coutts et al., 2015).

Tree in the urban area provides ecosystem services that can help in contributing to high quality urban living, improves physical urban environment and human health. Tree provides shading through tree canopy that can reduce the mean radiant temperature and evaporative cooling through their leaves in addition to the blocking of short-wave radiation by reflecting and transmitting the radiations thus lowering the surrounding air temperature (Kong et al., 2015). Georgi and Zafiriadis (2006) stated that urban tree can improve the HTC by prevent solar radiation from heating up the surrounding, affecting the evapotranspiration process thus cooling the surrounding and can reduce the speed of the wind.

## 1.2 Problem Statement and Justification

World Wildlife Foundation (2018) reported that the climate is under risk as shown in Figure 1.1 that the global warming can reach up to 2°C which can affect numerous factors such as extreme weather, arctic sea ice, sea-level rise, water availability, cost, food, ocean, coral bleaching, species and also human population. One of the effects is on human population where with global warming at 1.5°C, only 9% of human population will be exposed to extreme heat waves every 20 years compared to 28% if the global warming reaches 2.0°C.

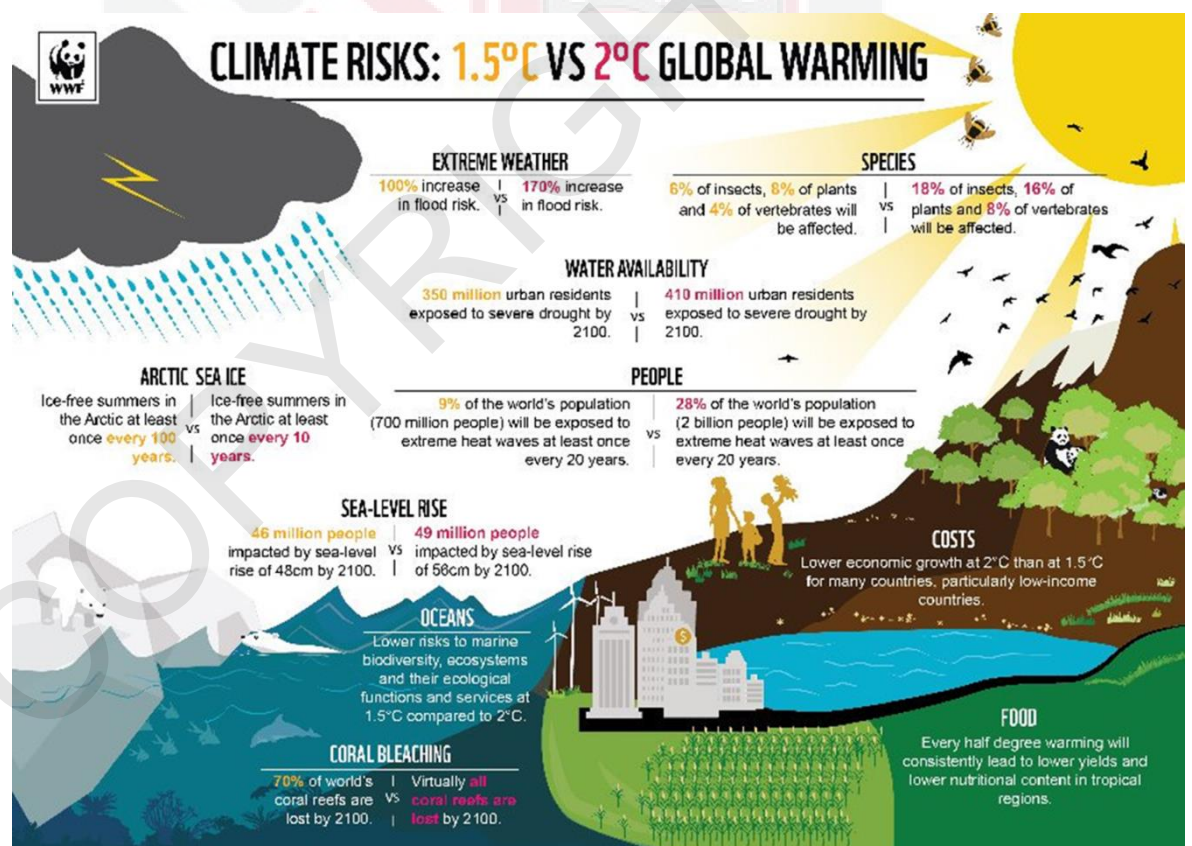


Figure 1.1: Effects of global warming

Even when the increment of global warming is only 0.5°C, the possibility to extreme heat waves exposure to human population will be increased by 19%. Figure 1.2 from NASA's Goddard Institute for Space Studies (GISS) (n.d) shows that the global temperature increased abnormally since 1880 with average of 0.8°C. Intergovernmental Panel on Climate Change (2018) reported that increment of global warming is to be kept at maximum 1.5°C to reduce detrimental impact on ecosystem, well-being and human health. This has become a global concern as heat wave events can influence the human health especially on heat related issues. For instance, there were 14 cases of heat exhaustion and heat stroke been recorded in Malaysia in 2016 and 2 cases that lead to mortality during the heat waves phenomena (Shahar, 2016).

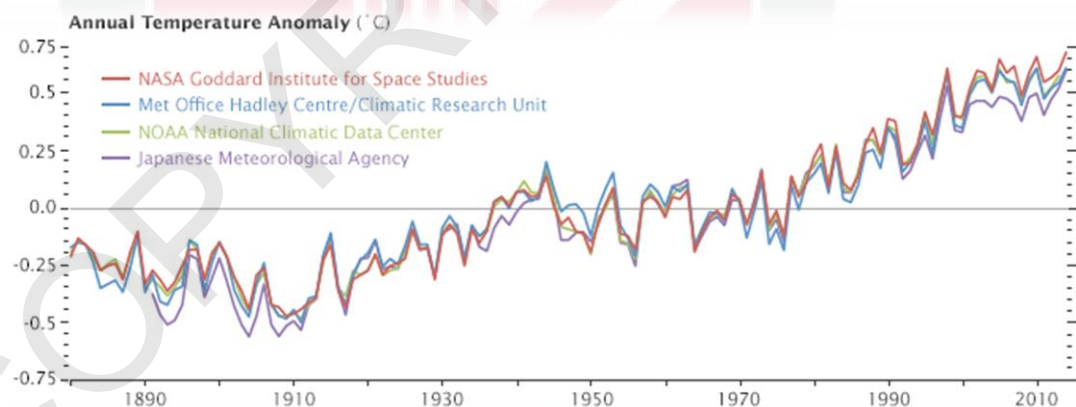


Figure1.2: Graph of temperature abnormal from 1880 until 2014



Therefore, in order to maintain the global warming at 1.5°C, the use of green infrastructures such as urban parks can improve microclimate condition and therefore human thermal comfort (Abreu-Harbich et al., 2015). Trees in urban parks provide ecosystem benefits such as the microclimate mitigation and human thermal comfort improvement as the concept of urban park itself that consists of diverse vegetation compositions including shrubs and flowering plants as well as water bodies such as lake or river (Konijnendijk et al., 2013).

However, this can lead to different ecosystem services each urban park may offer that influenced by the vegetation type in the park and the percentage of tree coverage (Nowak and Heisler, 2010). As each park has their own landscape design and vegetation structure, it produces specific quality of the microclimate conditions that simultaneously can influence individual's thermal condition and perceptions (Mahmoud, 2011).

Hence, the differences of vegetation in each urban park can give different HTC since human body depends on the surrounding temperature to produce heat in metabolism process (Fincer and Boduch, 2009). Therefore, in order to answer the question on either different urban parks can provides different HTC, the estimation of human thermal bioclimatic at different type of urban parks is important to be done as it can affect the human physically and psychologically. Moreover, this study will be beneficial in helping the park management to improve the landscape design in order to fulfil the people's thermal satisfaction.

### 1.3 Objectives

The objectives of this study were:

- i. To investigate the influence of different types of park on human thermal comfort condition.
- ii. To determine the relationships of human thermal comfort with tree characteristics



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