THE MICROCLIMATE BENEFITS OF STREET AND PARK TREES IN PUTRAJAYA

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THE MICROCLIMATE BENEFITS OF STREET AND PARK TREES IN PUTRAJAYA

By

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DEDICATION

Specially dedicated to my beloved parents,

Encik Zainurdin Bin Mohd Nor

Puan Fauziah Binti Mahayudin

Great siblings,

Haiqal Najmi Bin Zainurdin

Haiqal Aizad Zainurdin

My supervisor,

Dr. Ruzana Adibah Binti Mohd Sanusi

My co-supervisor

Dr. Diana Emang

And to all my friends.

Thanks for your encouragement, help, and your moral support.

ABSTRACT

Urbanization alters the urban environment and climate. Green infrastructure such as trees in the urban area plays an important role in mitigating the microclimate. Therefore, this study investigated the benefits of street and park trees in Putrajaya. The main objectives of this study wereto compare the microclimatic condition between residential street and urban park at Taman Saujana Hijau. In addition, this study also aimed to evaluate association between the distance from urban park and microclimate benefits. Microclimate variables such as air temperature, relative humidity, wind speed, and solar radiation were measured at both sites. Results from thisstudy showed that that trees in thepark had greatermicroclimate benefitscompared to the residential area where mean of air temperature at park was 34.3°C while in the street was 35.5°C. Distance from urban park influenced the microclimate as the air temperature and solar radiation were increased with distance especially during solar noon due to canopy openness. These results showed that trees urban park provides better microclimate benefits than trees in the street due to greater canopy coverage in the park. This study will be beneficial to the urban forest managers to increase tree coverage in the street areas to improve the street microclimate.

ABSTRAK

Perbandaran mengubah persekitaran bandar dan iklim. Infrastruktur hijau seperti pokok dikawasan bandar memainkan peranan yang penting dalam mengurangkan iklim mikro. Oleh itu, kajian ini menyiasat mengenai manfaat pokok jalan dan taman di Putrajaya. Objektif utama kajian ini adalah untuk membandingkan keadaan mikroklimatik antara jalan kediaman dan taman bandar di Taman Saujana Hijau. Di samping itu, kajian ini juga bertujuan untuk menilai hubungan antara jarak dari taman bandar dan faedah iklim mikro dikawasan tersebut. Pembolehubah mikroklimat seperti suhu udara, kelembapan relatif, kelajuan angin, dan sinaran matahari diukur di kedua-dua tapak kajian. Hasil daripada kajian ini menunjukkan bahawa pokok-pokok di taman bandar mempunyai manfaat mikroklimat yang lebih tinggi berbanding dengan kawasan kediaman di mana suhu udara di taman adalah 34.3 ° C manakala di jalan adalah 35.5 ° C. Jarak dari taman bandar mempengaruhi iklim mikro kerana suhu udara dan sinaran matahari meningkat dengan jarak terutamanya pada waktu tengah hari kerana keterbukaan kanopi pokok. Keputusan ini menunjukkan bahawa pokok-pokok dikawasan taman bandar memberikan faedah mikroklimat yang lebih baik daripada pokok di jalanan kerana jumlah kanopi yang lebih besar di taman tersebut. Kajian ini akan memberi manfaat terutamanya kepada pengurus hutan bandar untuk menambah bilangan pokok dikawasan jalanan bagi meningkatkan lagi iklim mikro.

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APPROVAL SHEET

I certify that this research project report entitled “The Microclimate Benefits of Street and Park Trees in Putrajaya” has been examined and approved as a partial fulfillment of the requirements for the degree of Bachelor of Forestry Science in the Faculty of Forestry, Universiti Putra Malaysia.

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UHI	Urban Heat Island
PAI	Plant Area Index
GHG	Green House Gas
SVF	Sky View Factor
HTC	Human Thermal Comfort
GLAMA	Gap Light Analysis Mobile Application

CHAPTER 1

INTRODUCTION

1.1 General Background

Rapid urbanization changes the urban landscape and modifies the urban climate. Urbanization also can be defined as the rapid growth of human population in a small areas who need civic amenities, socio economic and environmental degradation (Tahir *et al*., 2015). Nelson *et al*. (2009)claimed that, the urbanization and climate change can induce to undesirable affect.Thus, benefits from urban forest are needed to mitigate the urbanization impact on urban environment especially in the developing countries (David *et al*., 2017).

One of the impacts of urbanization on urban environment is the changes in the microclimates of the urban areas (McCarthy*et al*., 2010). Microclimates can be defined as the measured climatic parameters such as air temperature within the small area on earth's surface (Geiger, 1965). Some of the environmental factors that influence the microclimates are wind speed, light intensity, relative humidity and also air temperature (Chen *et al*., 1999). Climate basically depends on air and surface temperature, direct and diffuse solar irradiation levels on both horizontal and vertical surfaces, wind speed and direction in a dense urban area (Shahrestani *et al*., 2015). Besides that, microclimate also depends on the earth landscape including the corridors of streams, roads, and power lines (Chen *et al*., 1999) and the distance between parts of land such as urban, suburban, exurban and rural (Forman, 1995; Chen *et al*., 1996).

Urbanization has caused people migrating from the rural area to the cities in order to improve their quality of life (Grimm *et al*., 2008). Although people can gain a lot of benefits from the urbanization such as good settlement areas, work opportunity, education and economic benefits, urbanization has adverse influence on the environmental ecosystem that resulted in poor environmental quality. For example, people living in the urban area are exposed to human health problem such as heat stress that exacerbate by the Urban Heat Island (UHI) effect. UHI is defined as the phenomenon where the temperature of the urban areas is higher than the surrounding areas or the rural areas (Arifwidodo & Tanaka, 2015). It can caused the environment to become heat and polluted which result in high mortality rate of biodiversity, reduce the human comfort and increase the energy demand of building (Mirzaei, 2015).

Urbanization has also caused the reduction of green areas as the green areas have been transformed into pavements and built areas as well as using artificial material such as concretes for commercial, residential and other purposes (Zhou & Wang, 2011). This has resulted in the changes of the local climate due to the decrease in the number of the trees and other plant. Thus, trees and other vegetation help in mitigating the environmental impact in the urban areas. For example, trees of the urban area are helping in ameliorating the environmental ecosystem by reducing the air temperature and provide cooling effect via evapotranspiration process. It also can prevent a direct solar radiation from penetrating to the ground surfaces which causes reduction of heat absorbed by the surfaces thus reduces air and surface temperature of an area (Allegrini et al., 2015a). Trees also can provide a thermal comfort condition to the people living in urban areas (Abreu-Harbich *et al*., 2015). In addition, trees provide other ecosystem services to the environment such as help in ‘cleaning’ the urban environment from air pollutions (Manes et al., 2014).

1.2 Problem Statement

Street can be considered as a part of urbanization that is characterized by opening spaces for transportation which this characteristic has significant roles in creating the urban microclimates (Behrens, 2010). As urban street is mainly used for transportation and as pathways for pedestrian, green elements on the street such as trees is important as they can provide ecosystem services such as improving air quality through the removing of any pollutant and dangerous gaseous in the environment (Manes et al., 2014;Bolund *et al*., 1999). The urban street trees and shrubs have the ability to remove the gaseous air pollutant through the uptake via leaf stomata (Nowak *et al*., 2006). In addition, street trees also can reduce the surface water runoff during heavy rainfall events due to role of tree as in the interception process (Armson *et al*., 2013).

Moreover, urban street trees also can give an influence to the surrounding microclimates. Street with trees contribute to the reduction of relative humidity and ambient air temperature of the urban area as much as 5.6°C (Vailshery *et* *al*., 2013). Street trees at different street orientations also help in cooling by 0.2°C -0.6°C in shallow and broad street canyon (Coutts *et al*., 2016). Besides that, street trees and green areas also can increase the quality of air temperature and help save the energy through the evapotranspiration process (Georgi & Zafiriadis, 2006). However, microclimates also may vary between different types of plant species depending on the tree characteristics (i.e. leaf size, Plant Area Index) (Sanusi *et al*., 2017).

On the other hand, park trees also provide ecosystem services similar to the street trees as the tree canopies in park can enhance the environment by providing shade for people who conducting outdoor activities and recreation, reduce air temperature, improve human thermal comfort and control a good wind flow (Nasir *et al*., 2015).

In the case of urban-rural gradient (urban, suburban, exurban and rural), along the urban-rural gradient shows different microclimates due to the changes of environmental landscape elements such as different tree and building densities and types of trees planted in these areas (George *et al*., 2007). Changes of the landscape elements have resulted in different microclimate condition between different areas; for instance, the urban area has greater air temperature compared to the rural area (George *et al*., 2007). Similar to the urban-rural gradient context, park and street may have different microclimate such as different air temperature and relative humidity due to the difference of their environments such as difference in the density of green vegetation and other infrastructures in park and streets (Georgi & Zafiriadis, 2006). Thus, it is important to look at the differences in microclimate benefits of trees in street and park landscapes as these areas may have different microclimate benefits due to the difference of their landscapes.

Moreover, proximity to park also can have an influence on the microclimate. This is because, due to the difference of natural environment and the artificial structures that are present around the area (Clement & Castleberry, 2013). And there are also many other factors that can influence the changes of microclimates proximity to the park. Therefore it is important to investigate on how does the distance between street and park can influence the microclimate of an area.

1.3 Objectives

Therefore, main objectives of this research were:

a) To compare the influence of trees on microclimatic benefits between street and park.

b) To evaluate association between the distance from urban park and microclimate benefits.

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