



**EVALUATION OF CARBON SEQUESTRATION RATE  
TOWARDS LANDSCAPE PLANTING DESIGN AT  
URBAN PARKS IN SUBANG JAYA, SELANGOR**

**BY**

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

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**JULY 2017**

## ABSTRACT

This research is done based on the current environmental issues concerning the high released of carbon emissions. Carbon emissions are expected to continue to increase unless major changes are made in the way carbon is managed. Managing urban carbon emissions has emerged as an area of critical research and has become a key national agenda since the last century. This understanding leads to research questions and objectives about the carbon sequestration by plants and its contributions. A promising approach to reducing carbon emissions into the atmosphere is by carbon sequestration through selecting appropriate plant materials as well as optimisation of spatial and space organisation of green spaces. Thus, the aim of this research is to evaluate the carbon sequestration rate (CSR) towards landscape planting design of urban parks in Subang Jaya, Selangor. While, the objectives of this research are to calculate the carbon sequestration rate produced by different landscape planting design at selected urban parks, to identify which type of landscape planting design is effective in sequestering carbon emissions and lastly, to offer recommendations toward optimising the carbon sequestration rate. The research methodology addressed three steps approaches consisted of inventory and analysis, calculation, lastly followed by recommendations to overcome the issues. In this study, the information needed to calculate CSR are only the plants specifications such as heights, diameter, age and quantity and lastly the size of area and percentage of green area of the selected sites. Thus, the landscape planting plan of selected sites was collected by local authorities. Three urban parks with different landscape planting design comprising Subang Jaya Urban Park (Informal Landscape Planting Design), Putra Heights Neighbourhood Park (Curvilinear Landscape Planting Design) and Linear Park (Linear Landscape Planting Design) were assessed for the relationship between the landscape planting design and the carbon sequestration rate. Our findings revealed that, the informal landscape planting design is more effective in absorbing the carbon emissions rather than curvilinear and linear landscape planting design. The study also found that the tree is the most powerful agent in absorbing the carbon emissions in the atmosphere. The significant outcomes of this assessment will be a novel landscape design approach to neutralising carbon emission which is cost effective and environmental friendly. This study offers new knowledge for various parties such as developers, designers and landscape architects to reduce global carbon emissions.

## خلاصة البحث

تم اتمام هذا البحث بناء على المسائل البيئية الحالية والمتعلقة بالانبعاثات العالية للكربون ومن المتوقع ان تستمر انبعاثات الكربون في الزيادة ما لم يتم عمل تغييرات شاملة في كيفية إدارة انبعاثات الكربون في المناطق الحضرية لديها. وقد برزت إدارة انبعاثات الكربون كمجال للبحوث الحرجة وأصبحت جدول أعمال وطني رئيسي منذ نهاية القرن الماضي ويؤدي هذا التفهم إلى طرح أسئلة وأهداف بحثية حول مساهمات عزل الكربون عن طريق النباتات وإسهاماتها. والتي تعتبر نهج واعد للحد من انبعاثات الكربون في الغلاف الجوي بواسطة عزل الكربون عن طريق اختيار المواد النباتية المناسبة وكذلك تحسين التنظيم المكاني والمساحي للمساحات الخضراء. لذلك فإن هدف هذا البحث هو تقييم معدل عزل الكربون (CSR) نحو تصميم المناظر الطبيعية للحدائق الحضرية داخل سيلانغور. في حين أن أهداف هذا البحث هي حساب معدل عزل الكربون الناتج عن تصميم المناظر الطبيعية للمساحات الخضراء زراعة في الحدائق الحضرية المختارة، لتحديد أي نوع من التصميمات فعالة في عزل انبعاثات الكربون. وأخيراً، تقديم التوصيات اللازمة للتغلب على هذه القضايا نحو تحسين معدل عزل الكربون. وتناولت منهجية البحث ثلاث خطوات تتكون من المخزون والتحليل، والحساب، تليها أخيراً التوصيات للتغلب على تلك القضايا. في هذه الدراسة، فإن المعلومات اللازمة لحساب المسؤولية الاجتماعية للشركات هي فقط مواصفات النباتات مثل الارتفاعات، القطر، العمر والكمية وأخيراً حجم المساحة والنسبة المئوية للمنطقة الخضراء في المواقع المختارة. وهكذا، فإن خطة زراعة المناظر الطبيعية بالمواقع المختارة من قبل السلطات المحلية. ثلاثة حدائق حضرية بتصميمات مختلفة تضم سوبانج جايا (تصميم المناظر الطبيعية الغير رسمي)، بوترا هايتس نايبورهود بارك (تصميم المساحات الخضراء منحنى الاضلاع) و لينيار بارك (تصميم المناظر الطبيعية الخطية) لتقييم العلاقة بين تصميم المساحات الخضراء للمناظر الطبيعية، ومعدل عزل الكربون. وكشفت نتائجنا أن، تصميم المناظر الطبيعية الغير رسمي هو الأكثر فعالية في امتصاص انبعاثات الكربون بدلاً من التصميم الزراعي المنحني والخطي. ووجدت الدراسة أيضاً أن الشجرة هي العامل الأكثر قوة في امتصاص انبعاثات الكربون في الغلاف الجوي. المهم فإن نتائج هذا التقييم ستكون نهجاً جديداً لتصميم المناظر الطبيعية لتحديد انبعاثات الكربون والتي هي فعالة من حيث التكلفة وكونها صديقة للبيئة. تقدم هذه الدراسة الجديدة والمعرفة لمختلف الأطراف مثل المطورين والمصممين والمهندسين المعماريين للمناظر الطبيعية والحد من انبعاثات الكربون العالمية.

## APPROVAL PAGE

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## 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.

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*This thesis is dedicated to my late grandmother, Hasmah binti Idris  
(1938-2010). May Allah SWT give her the highest place in Jannah, Ameen.*

## ACKNOWLEDGEMENTS

*Bismillahirrahmanirrahim*

*Alhamdulillah thumma Alhamdulillah.*

First of all, I praise Allah the Almighty for providing me with this opportunity and granting me the capability to successfully complete this Master thesis. May Peace and Blessings of Allah be upon His Prophet Muhammad (peace be upon him).

This thesis appears in its current form due to the assistance and guidance of several people. I would like to offer my sincere thanks to all of them. To my supervisor, Asst. Prof. Dr. Maheran Yaman, and my co-supervisor Asst. Prof. Dr. Fadzidah Abdullah, my heartfelt thanks for accepting me as a Master student, and for your warm encouragement and thoughtful guidance. I would like to express my deep gratitude to my respected lecturer specialising in carbon sequestration, Assoc. Prof. Dr. Rashidi Othman for the trust, insightful discussion, valuable advice, support, especially for your patience and guidance during the writing process. I would like to thank all my friends especially members of The International Institute of Halal Research and Training Laboratory (INHART), Sr. Farah Ayuni Mohd Hatta, Sr. Razanah Ramya, Sr. Nur Alifah Mohd Amin, Br Muhammad Shirwan Abdullah Sani, Br. Mohd Akram Abdul Rasid, Br. Hazree Ahmad and Sr. Nurul Azlen Hanifah for their excellent advice during the preparation of this thesis.

I warmly thank and appreciate my very supportive husband, Syed Mohamed Syed Hassan. I thank Allah SWT for blessing me with a beautiful and sweet daughter, Sharifah Khadeeja Syed Mohamed. My deepest gratitude also goes to my beloved family, parents, *Abah*, Mr. Mohd Noor, *Mama* Mrs. Rohanah Omar and my family in-law for their support and encouragement. To my brothers and sister, Mohd Faizal, Mohd Fakhruzzaman, and Nur Fadhilah, I am grateful for your limitless love, *dua* and encouragement. Only Allah will reward all of you for all your invaluable assistance. It is my sincere hope that this study will be of benefit to all who read and pursue its many implications.

This thesis is humbly dedicated to the Master of Science (Built Environment) and Department of Landscape Architecture, Kulliyah of Architecture and Environmental Design, International Islamic University Malaysia.

*Jazakumullah khairan katsiran. Wa jazakumullah ahsanal jaza*

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## LIST OF SYMBOLS

m <sup>2</sup>	Meter squared
TCO <sub>2</sub> e	Tonne carbon dioxide equivalent
KgCO <sub>2</sub> e	Kilogram carbon dioxide equivalent
°C	Degree celcius
%	Percent

## ABBREVIATIONS

S.W.T	Subhanahu Wa Ta’ala (Praise be to Allah and the Most High)		
CSR	Carbon sequestration rate	MyCREST	Malaysian Carbon Reduction and Sustainability Tools
GHG	Greenhouse gases	LCS	Low carbon society
UNFCC	United Nations Framework Convention On Climate Change	EIA	Energy Information Administration
GDP	Gross domestic product	CIDB	Construction Industry Development Board
KKR	Kementerian Kerja Raya Malaysia	JKR	Jabatan Kerja Raya Malaysia
LCCF	Low Carbon City	KeTTHA	Ministry of Energy, Green Technology, and Water Framework
LPD	Landscape Planting Design		

# **CHAPTER ONE**

## **INTRODUCTION**

### **1.1 INTRODUCTION**

This chapter highlights the research of carbon emissions release and function of urban parks, carbon sequestration rate by plantings, particularly on urban parks in Selangor. The chapter begins by addressing the current issues of carbon emissions in global and Malaysia context. The chapter then addresses problems such as the impact of carbon emissions released and carbon sequestration rate towards plants in urban parks. In the second part, the chapter outlines the research aim, questions, objectives, significant, scope and limitation of the research. Finally, the chapter highlights the research structure.

### **1.2 RESEARCH BACKGROUND**

Human anthropogenic activities have direct and indirect effects on ecosystems (Chapin et al., 2002). Most human activities release high rates of carbon emissions into the atmosphere. Global climate change, urban heat island, degradation of ecosystem are examples of effects from high released of carbon emissions into environment. Apart from that, a low relative carbon footprint city deserves the attention of scholars and urban stakeholders as it represents a virtuous model of a city with low carbon emissions in an environment where the national average is high (Schio and Brekke, 2013). For Malaysia, the leading sectors recognised to subsidise the emission of CO<sub>2</sub> are electricity generation, transportation, industrial and residential (Safaai et al., 2010). There is one organization in Malaysia known as Malaysian

Carbon Reduction and Sustainability Tools (MyCREST) was established to reduce carbon emissions using rating system or scorecard to rate the level of carbon emissions released and it will be made compulsory for all government projects valued at RM50 million and above (MyCREST, 2015). The organization promotes holistic approach in managing carbon emissions by considering the capacity of the ecosystem to assimilate the carbon emissions released. One approach to reducing the carbon emissions as highlighted by MyCREST is called ‘carbon sequestration’. The process refers to the long-term storage of carbon in oceans, soil, vegetation and geologic formations (Great Lakes Bioenergy Research Center, 2009). Many organisations around the world are trying to reduce the carbon emissions released into the environment.

In cities, it is a must to have an urban parks. Urban parks are well-defined as open space areas, generally conquered by plants and water, and usually reserved for public use (Konijnendijk et al., 2013). Konijnendijk et al., 2013 also mentioned, urban parks have many benefits towards human and environment especially in terms of reducing air pollution and carbon sequestration. Cavanagh et al. (2009) agreed, the function of urban trees in reducing air pollution, in terms of intercepting atmospheric particles and captivating numerous gaseous contaminants.

Since, most of studies only focusing on modelling system of carbon sequestration rate and soil sampling, this research seeks to evaluate the carbon sequestration rate towards landscape planting design of urban parks. Thus, develop recommendations that significantly help in optimizing the carbon sequestration rate. As mentioned before, carbon sequestration is one of many valuable environmental services provided by plants. The process also benefits in cooling the earth’s temperature. Hence, this study helps scholars and other stakeholders to understand the

ability of plant materials and landscape planting design to sequester carbon. It also highlights how to calculate the carbon sequestration rate produced by plants using the carbon sequestration rate calculation. Moreover, it may contribute towards introducing new knowledge and technology, consequently improving the management of CO<sub>2</sub> emissions without harming the surrounding environment. This research might also help promote the concept of sustainability in the built environment, cost-effective and eco-friendly technology to remedy environmental pollution. Besides, the green technology such as carbon sequestration is a scientific and technological knowledge could be beneficial to the community as well as future generations.

### **1.3 ISSUES**

Cities are complex ecological and social systems which have strong interactions with the world. Cities have been blamed for climate change in comparison to rural and semi-urban areas (Girardet, 1998). All activities will, directly and indirectly, affect the environment. As reported by Wiedmann and Minx (2008), the carbon footprint measures the quantity of greenhouse gases (GHG) emitted into the atmosphere. Higher levels of income and the concentration of economic and social activities that characterises cities lead directly to higher levels of energy consumption and waste generation (Dodman, 2009). Apart from that, cities have been estimated to produce up to 80% of global greenhouse gases and from that the opportunity for effective climate change mitigation is high (McCarthy et al., 2010). Studies have revealed that global warming is mainly due to the high rate of carbon emissions and other greenhouse gases.

Apart from that, Soon et al., (2007) found that the earth's average temperature has increased since the past 3000 years by an estimated 3°C. If the carbon emissions

continue to be released, it will lead to further changes in the climate (The Royal Society and National Academy of Science, 2014). Wolff et al. (2014) highlighted that climate change manifests in the migration of populations, the destruction of species, ocean circulation and changes in land surface. Soon et al., (2007) also revealed that global warming resulted in the shortening of world glaciers because glaciers frequently grow in delayed connection with cooling and warming trends. Other negative impacts of the carbon emissions in relation to the environment were mentioned by King (2005) such as the increment of water vapour, losses of parks, changes in vegetation composition, increased acidification of the oceans, extreme weather events, and flooding and altered ecosystems that will greatly modify biodiversity. Hence, studying carbon sequestration is essential to help mitigate the above environmental issues.

#### **1.4 PROBLEM STATEMENT**

Due to awareness about the loss of ecosystems and its environmental and societal effects caused by carbon emissions such as the negative impacts of high rates of carbon emissions such as global warming, climate change, changes in vegetation and environment, improper carbon management of human activities, and the degradation of ecosystems, many researchers have initiated studies on phytotechnology known as “carbon sequestration” to reduce global carbon emissions (Aguaron and Pherson, 2012; Strohbach et al., 2012; Churkina, 2012).

Safaai (2010) also agreed, the high release of carbon emissions will lead to global warming and other negative environmental impacts such as storms, floods and droughts. IPCC (2007) added, the rate of warming is remarkably changed which the minimum temperatures increasing more rapidly than maximum temperatures and land

areas have inclined to warm quicker than ocean areas and the winter months have warmed sooner than summer months.

A lot of research has been devoted towards carbon sequestration rate using modelling and soil sampling (Garry, 2009; Nowak et al., 2006; Voglander et al., 2013; Baral and Guha, 2003; Selhorst and Lal, 2012). However, no research has been reported on assessment of carbon sequestration rate towards landscape planting design. Thus, it is important to do research on CSR towards landscape planting design as it can be as a new knowledge to researchers and designers in designing the space with functionality.

### **1.5 RESEARCH QUESTIONS**

1. What is the current amount of carbon sequestration rate produced by different landscape planting design at selected urban parks?
2. Which type of landscape planting design is effective to sequester carbon emissions?
3. What are the recommendations for optimising the carbon sequestration rate?

### **1.6 RESEARCH AIM**

This study seeks to evaluate the carbon sequestration rate towards landscape planting design of urban parks in Subang Jaya, Selangor.

### **1.7 RESEARCH OBJECTIVES**

To achieve the aim of the research, the following objectives have been formulated:

1. To calculate the carbon sequestration rate produced by different landscape planting design at selected urban parks.
2. To identify which type of landscape planting design is effective in sequestering carbon emissions.
3. To offer recommendations toward optimising the carbon sequestration rate.

### **1.8 RESEARCH SIGNIFICANCE**

Plants need carbon dioxide to produce their food. However, in recent years, due to many human activities such as burning fossil fuels that release the high rate of CO<sub>2</sub> emissions, the destruction of the ecosystem has become a serious global environmental issue. The poor management of carbon emissions has negatively affected the quality of the environment and resulted in global warming, climate change and haze among others. Although several alternatives have been introduced to mitigate these problems, they have been ineffective because of a general lack of understanding of this problem. Hence, green technology such as carbon sequestration should be practised as an alternative to remediate the contaminated air in the environment. A thorough study of the effectiveness of this green technology might contribute towards a sustainable built environment in terms of social, ecological and economic benefits. This study also contributes to various fields such as:

- i. Creating the tools for designers to calculate carbon sequestration rate in optimising green space.
- ii. As a new body of knowledge of landscape architecture in designing outdoor area with functionality.
- iii. Educate the public on how to appreciate Parks as a carbon sink.