DIVERSITY OF URBAN TREES IN INTERNATIONAL COLLEGE OF ADVANCED TECHNOLOGY SARAWAK (ICATS)

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Master of Environmental Science (Land Use and Water Resource Management) 2013
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This project is submitted in partial fulfilment of the requirements for the Master of Environmental Science (Land Use and Water Resource Management)
DECLARATION

No portion of the work referred to in this dissertation has been submitted in support of an application of another degree of qualification of this or any other university or institution of higher learning.

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<td>CO₂</td>
<td>Carbon dioxide</td>
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<td>DBH</td>
<td>Diameter breast height</td>
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<td>GHG</td>
<td>Green house gases</td>
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<td>ICATS</td>
<td>International College of Advanced Technology of Sarawak</td>
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<tr>
<td>IPCC</td>
<td>International Panel on Climate Change</td>
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<tr>
<td>JKR</td>
<td>Jabatan Kerja Raya</td>
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<tr>
<td>m</td>
<td>Meter</td>
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<tr>
<td>n.d.</td>
<td>No date</td>
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<tr>
<td>PM</td>
<td>Particle matter</td>
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<td>PPKS</td>
<td>Pusat Pembangunan Kemahiran Sarawak</td>
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<tr>
<td>SDI</td>
<td>Simpson's Index of Diversity</td>
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<tr>
<td>US</td>
<td>United States of America</td>
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<tr>
<td>VOC</td>
<td>Volatile organic compound</td>
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<tr>
<td>°C</td>
<td>Degrees celsius</td>
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<td>%</td>
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Diversity of Urban Trees in
International College of Advanced Technology Sarawak (ICATS)

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ABSTRACT

Trees are an important urban resource and should be looked at as a critical piece of urban infrastructure. With effective planning and management, urban trees and forests will provide a wide range of important benefits to urbanites. International Colleague of Advanced Technology Sarawak (ICATS) set up at Tabuan Jaya and is still under development or ongoing construction. There has not yet been a measured of Species Diversity. The main aim of this project is to assess the diversity of trees in the ICATS. The assessment is determined by calculating the number of tree species and diameter breast height (DBH) of each species. Species diversity index (SDI) of trees at ICATS is 9.48 and is considered relatively low. The 149 trees enumerated in the study area include 15 species. The most abundant species is Areca triandra species was dominant species contributing 23 individual trees. Samanea saman is the second as the most dominant species contributing 21 individual trees.

Keywords: Species diversity index, urban forest, urban trees.

ABSTRAK


Kata kunci: Indeks kepelbagaian spesies, hutan bandar, pokok bandar.
CHAPTER 1

INTRODUCTION

1.1 Introduction

International College of Advanced Technology of Sarawak (ICATS) is wholly owned by PPKS Ilmu Sdn. Bhd., a subsidiary company of Pusat Pembangunan Kemahiran Sarawak (PPKS). The college ICATS was set up at Tabuan Jaya and is still under development or ongoing construction. There has not yet been any documented measurement of species diversity of street trees at ICATS. Therefore, there is a need to assess the diversity of species in the ICATS area as it will provide database that which will provide useful information for maintenance purposes and also to provide the basis for future sustainable development management plan.

Furthermore, the college area has been developed with continuous construction in the past few years, but regretfully the urban trees planting are still in consideration and planning especially in the construction area. Trees are the basic plan for any landscape design. The type used and their location determines whether the planting are appropriate or not. Many trees will live for more than 100 years if they are given a chance with proper care and maintenance. Because of the permanency of urban trees and their importance to the environment, care must be taken to select the best species. Trees provide shade thus cool the certain area in the environment, especially the area in the parking lots. Parking lots occupy about 10 percent of the land in our cities and 20 to 30 percent of the downtown core area (Beatty, 1989). In the city area, parking space can be significant sources of heat, air pollutants, water pollutants, and visual blight. Since parking lots have been recognized as thermal "hotspots", California cities such as Sacramento, Modesto, Los Angeles, and Davis have implemented ordinances that require shading of 50 percent of paved areas by
trees (McPherson & *et. al*, 2002). Unshaded parking lots can be viewed as miniature heat islands, where temperatures can be even higher than surrounding areas. However, if there are trees available, the tree canopies will reduce the air temperatures significantly.

Although the bulk of hydrocarbon emissions come from tailpipe exhaust of vehicles, 16% of hydrocarbon emissions are from evaporative emissions that occur when the fuel delivery systems of parked vehicles are heated (McPherson & *et. al*, 2002). These evaporative emissions and the exhaust emissions of the first few minutes of engine operation are sensitive to local microclimate, in this case the ICATS parking area. If cars are shaded in parking lots, evaporative emissions will be greatly reduced.

The Kyoto Protocol was obligatory on 16 February 2005 that is generally seen as important first stage near a truly global emission decrease regime that will stabilize GHG emission, and provides the essential architecture for any future international agreement on climate change. There are new international framework that have been negotiated and ratified that can be deliver the stringent emission reduction the International Panel on Climate Change (IPCC) that has clearly indicated by the end on the first period of the Kyoto Protocol in 2012.

Nowak (2000) reported that trees reduce temperatures and smog and with an extensive and healthy urban forest air quality can be drastically improved. Trees help to lower air temperatures and the urban heat island affect in urban areas. This reduction of temperature not only lowers energy use, it also improves air quality, as the formation of ozone is dependent on temperature.

- As temperatures increase, the formation of ozone increases (Nowak, 2000).
- Healthy urban forests decrease temperatures, and reduce the formation of ozone (McPherson & *et. al*, 2002).
- Large shade trees can reduce local ambient temperatures by 3 to 5 °C (McPherson & et. al, 2002).

- Maximum mid-day temperature reductions due to trees range from 0.04 °C to 0.2 °C per 1% canopy cover increase (Nowak, 2000).

- It was estimated that doubling the canopy cover to five million trees would reduce temperatures by 3 degrees. This reduction in temperature would reduce peak ozone levels by as much as 7% and smoggy days by 50% (Nowak, 2000).

1.2 Role of urban trees

Urban forestry is defined as the art, science, and technology of managing trees and natural systems in and around urban areas for the health and well being of communities. Practitioner combines strategic planning and best management practices with environment stewardship education to create sustainable, cost effective solutions for our cities and towns. For the environment function, urban trees can help to control air quality by mitigating air pollution and greenhouse gases (Brandon, 2013).

Trees help to improve air quality by mitigating air pollution & greenhouse gases. Most trees use photosynthesis to convert carbon dioxide (CO₂) into nutrients. The process helps to reduce the amount of CO₂ which is a greenhouse gas that would otherwise contribute to smog and unhealthy environmental conditions.

Spatial arrangement of plants in relation to building and other objects within the urban area is defined as structure of urban forest (Nowak, 1994). Structural attributes such as shape, size, height, flower fruits and other provided by trees give specific function of trees such as shade, beauty, and minimizing the air pollution. Management in planting and care are therefore important to keep this system for the benefits of human and environment.
(McPherson, 1998). While it can be difficult to quantify exactly how much air a particular tree improves, the US Department of Agriculture has found that one acre of forest absorbs six tons of carbon dioxide and puts out four tons of oxygen. This is enough to meet the annual needs of 18 people (National Leagues cities, 2012).

Shading streets, parking lots, and rooftops provides as much soil area as possible for planting areas to promote vigorous tree growth (McPherson, 2001). By providing shade and a barrier to wind, trees cool buildings during hot weather, and limit snow accumulations during cold weather. Economically, this is beneficial as it can reduce the fuel costs associated with heating and cooling the building.

Cultural Ecosystem Services is the term used for the nonmaterial benefits for people. Trees help to define a 'sense of place' and provide desirable landscapes: The aesthetic benefit of trees is obvious. Their size and colours can help to soften the often-harsh urban landscape. Species type, placement, and even long-standing individual trees can underscore regional history, culture, and identity (National Leagues cities, 2012).

Trees and urban forests encourage community social interaction where the green spaces are more preferable for people to gather. Trees help to reduce noise pollution by absorbing and blocking urban noise: This has been shown to reduce stress for people living and working especially in the hectic urban areas. Besides that many of the schools or varsities likes to participate for natural science curricula that are related to the trees.
1.3 Current scenarios in Kuching city

Kuching city is located just north of the equator at the heart of South East Asia, The city where great culture meet, where an exotic blend of the Malay and others is reflected in the diversity of her history, customs, and traditions. In Kuching city, urban tree planting is a recent scenario, as compared to other major cities in Peninsular Malaysia, Singapore, and Hong Kong. The roadside trees planted in Kuching city can be found abundantly. The areas usually planted with landscaping trees are areas such as roundabout, roadside, road dividers and junctions which have been planted with trees and palms of different species. The common trees that are planted in Kuching city is a mixture of indigenous and exotic species such as Callistemon lanceolatus, Samanea saman, Peltophorum pterocarpum, Pterocarpus indicus, Cinnamumum iners, Swietenia macrophylla, Michelia alba, Michelia champaka, Mimusops elengi, Lagerstroemia speciosa, Khaya senegalensis, Andera surinamisis, and Filicum decipiens (Siti, Durie, and Dayang, n.d.b).

Since 1960s, the space is getting limited for the growth due to the expansive of road and constructing new developments, these species are not suitable anymore to be planted at the roadside. For example, the more rapidly a tree exploits its entire limited root space, the greater is the ability to withstand episode of extreme soil-moisture depletion (Siti, Durie and Dayang, n.d.b). Thus the major factors controlling the survival and growth of urban tree is its ability to produce a root system that successfully exploits volume of soil to supply the moisture and mineral demands of the aerial organs (Howe, 1980: cited in Siti and Dayang, n.d.a). The main goal in selecting trees for limited space is to produce a long term harmonious relationship between the trees and its environment (Ware, 1998).

There are trees that are inappropriate to be planted at certain places. For example, species such as Pterocarpus indicus and Khaya senegalensis which are known to have
conflicts with utilities lines along the roadside. These large trees should be avoided or replace as to prevent any damage to the roadside and pavements and to avoid unnecessary accidents cause of their roots crack the roads due to limited space or improper maintenance. Only suitable trees should be selected for urban areas depend on the space limitation, Trees that need special or high maintenance such as frequent pruning or dropping messy fruit should be avoided. Leaf litter and twigs should be avoided as the trees must tolerate the urban conditions which are limited in soil volume and moisture. It is vital that only good trees that can tolerate this limited space be chosen accommodate the space adequately.

However, the effectiveness of landscape trees in Kuching city providing benefits to people are depending on their species composition, diversity, age and location with respect to people and other elements in landscape. It differs with each elements and individual.

There is a need for an integrated focus on the selection of cultivars for urban greening. The selection must be matched by simultaneous testing, in different place, as the selection of plants always in two – part process. The major purpose in selecting trees for limited spaces is to produce a long term pleasant relationship between the tree and the environment.

1.4 **Problem statement**

The college, ICATS was set up at Tabuan Jaya and is still under development or ongoing construction. There has not yet been a measurement of species diversity of street trees at ICATS. Therefore, there is a need to assess the diversity of species in the ICATS area as it will provide database that which will provide useful information for maintenance purposes and also to provide the basis for future development management plan.
Over time, the number of students increase and the usage of motor vehicles become abundant. The parking lots are limited in ICATS area. It is considered a normal phenomenon in private college where area for parking is inadequate. Therefore, space is getting limited for planting trees and some irresponsible administration may even considered planting them are inappropriate due to lacking of space. Even if some trees are chosen, the species may not be suitable to be planted at the site.

Failure to recognize the best tree species for planting in the area may result in various adverse effects. Therefore, there is an urgent need to survey the diameter breast height (DBH), structure, hazard, and condition of these trees for sustainable management purposes. Besides that, roughly there are less plant planted at the ICATS area and this may lead to microclimate affect in the surrounding area. It is important to know about the residence knowledge and their perspective about urban trees planted at the ICATS.

1.5 The objective of my study:

- To establish the diversity of trees in the International College of Advanced Technology of Sarawak (ICATS) for sustainable land use planning.
CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

Urban forest structure and health evaluation is highly important because it provides crucial characteristics of the green infrastructure (Smith et al. 2005). The foundation for the value of an urban tree could be emotional, aesthetic, or it could be stringently utilitarian. However, people seldom perceive value as strictly aesthetic or monetary. There is often substantial overlap that makes "value" difficult to classify. In many communities, public expenditure on tree care and management reflects an approximate value of trees. Spending patterns that go unchallenged, especially among an informed public, indicate the value people associate with trees.

Urban forest may be defined as the sum of all woody and associated vegetation in and around dense human settlement, ranging from small communities in rural areas to metropolitan regions (Miller, 1998). Trees provide living space for birds and small animals. The animals choose the trees as a shelter due to the clearing of their environment especially in the urban areas.

Trees help cleanse the air by intercepting airborne particles, reducing heat, and absorbing such pollutants as carbon monoxide, sulphur dioxide, and nitrogen dioxide. Trees remove this air pollution by lowering air temperature, through respiration, and by retaining particulates (Nix, 2013). Because tree transpiration cools air and leaf temperatures and thus reduces biogenic Volatile Organic Compound (VOC) emissions, tree and shrub VOC emissions are reduced in the model based on air quality modelling results (Nowak et al. 2000). This is beneficial to the people.

Species diversity can be referred as the number of species within a region or a given area. It is a function of the distribution and abundance of species. In more technical
literature, includes considerations of the evenness of species abundances. An ecosystem is said to be more diverse, according to the more technical definition, if species present have equal population sizes and less diverse if many species are rare and some are very common.

Sustainable trees are important for a sustainable city. Large shade trees make an enormous contribution to sustainable city but all too many trees planted every year will not survive long enough to reach effective size. Many factors are involved, but certainly the most important is the relationship between longevity and the planting methods. (Arnold, Hendry, 1993). The experience of some arborists and landscape architects suggests that incorrect installation of trees on hard-core urban sites is the number one obstacle to make the cities tree-shaded havens (Perry 1982; Urban 1989). Trees that are incorrectly installed so that they last less than 10 years are an unfortunate waste of resource and manpower.

2.1 Functions of urban trees

2.1.1 Carbon sequestration

Trees in urban areas reduce the amount of Carbon in the atmosphere in two ways. First, they store carbon as they grow. Second, they reduce the energy needed for urban heating and cooling, which in turn reduces the amount carbon dioxide produced by fossil-fuel power plants.

In the Chicago study, trees annually sequestered the equivalent amount of carbon emitted from all forms of transportation in one week (Nowak et al, 1994). With some additional tree planting, it was estimated that this could be increased to the amount of carbon emitted by two months of transportation use in Chicago.
2.1.2 Climate Moderator

There is an urgent need for re-greening. All new roads and pathways to and from the building schemes should be covered with shade and trees and, in so doing will moderate the hot temperature (Chaniago and Mohd, 1980). Generally, vegetation absorbs some solar energy for photosynthesis and greater amounts of solar energy in order to evaporate water and cool leaf surfaces (Miller, 1997).

Trees modify climate and conserve building energy use in three principal ways (Figure 1). First, trees save energy for heating and cooling by shading buildings, second, evapotranspiration converts liquid water to water vapor and thus cools the air by using solar energy that would otherwise result in heating of the air and lastly, reducing wind speeds. Wind-speed reduction reduces the infiltration of outside air into interior spaces and reduces heat loss, especially where conductivity is relatively high (e.g., glass windows) (Simpson, 1998). It is reported that tree shade can reduce the average air temperature in buildings by as much as 5°C (Akbari et al 1992). Studies in Malaysia showed that under trees air temperature could be 4°C lower than in exposed spaces (Yap, 1995).
2.1.3 Trees control noise pollution

Trees help to reduce noise pollution by blocking and absorbing urban noise such as noise from vehicles and construction of development (National Leagues cities, 2012). Noise can reach unhealthy levels in cities. Trucks, trains, and planes can produce noise that exceeds 100 decibels, twice the level at which noise becomes a health risk. Thick strips of vegetation in conjunction with landforms or solid barriers can reduce highway noise by 6 to 15 decibels. Plants absorb more high-frequency noise than low frequency, which is advantageous to humans, as higher frequencies are most distressing to people (Cook, 1978).
Trees can decrease the congestion of noise in the urban areas and also reduced stress for people living and working around trees like ICATS area itself is near the main road to Kuching city.

2.1.4 Trees shade and cool

Trees and other vegetation ameliorate local urban heat island effects through shading, evapotranspiration, and reducing summer cooling demands. Studies have shown that parts of cities without cooling shade from trees can literally be “heat island” with temperature as much as 12 degrees Fahrenheit higher than the surrounding areas (Blackburn, 2012). This is because the foliage found in green spaces improves air quality by reducing particulate air pollutants and gases such as ozone.

The solar energy which hits a certain green area is greatly used by the vegetation for its transpiration and photosynthesis processes, causing a sensible reduction in temperature (Figure 2) compare to highly settle urban areas, solar energy is reflected and absorbed by the building's vertical surfaces, increasing its thermal charge (Figure 3). It has been verified that the cooling off due to transpiration of a plant of large dimension equals the capacity of five small air conditioning devices working for 20 hours a day.