TREE HEALTH ASSESSMENT FOR ROADSIDE TREE IN KOTA KINABALU CITY CENTRE, SABAH

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ABSTRACT. *This study aimed to assess the health of main tree in the Kota Kinabalu City Centre, Sabah. In this study, principal evaluation standards were made by using visual observation of trees or Visual Tree Assessment (VTA). This study was conducted to identify any effect of damage or defect on trees via the observation of trees at their roots, stems, branches and leaves. There were five zones in the study area, namely from KK Lama and Jesselton Point (Zone 1) to Pasar Besar. The tree health parameters were evaluated from the presence of pests and diseases, trees health, foliage colour, the growth rate of trees, infections of the trees and potential failure of tree roots. In this study, nine of pathogens, pests and diseases of trees were observed, which were termites, fungi, aphid, mushrooms, epiphytes, parasites, ants, weeds and Whiteflies. This study showed that there were 23 species from the 688 stand of trees in the study area. The study found that the state average foliage colour was normal, a moderate growth rate and infection of the tree was still under controlled. The potential failure of tree root was found in low level as well. In a nutshell, the overall health of trees was found to be in good and moderate levels. This study was conducted as a reference in health detection of tree for The City Hall management (DBKK) and also as a reference for University students in conducting tree health assessment.*

KEYWORDS. Tree health assessment, roadside tree, Kota Kinabalu City Centre, Sabah

INTRODUCTION

Trees play important roles in natural ecosystems and urban areas. In the city, the trees contributed to the beauty and greenery of the areas. Trees in urban areas help in balancing the microclimate such as temperature and moisture. They can provide shading and control the speed of the wind. Trees also serve to reduce the noise level of sound in a place (Mojiol, 2018).

Naturally, the trees planted in the areas are beneficial to the local residents and visitors. The trees are part of the components that make up the urban ecosystems. Typically, a tree is planted in an urban area as a shade tree of that area. The presence of unhealthy trees will be a risk to users of these areas. Security is the main aspect that is needed to be addressed by the authorities in these urban areas (Gilman, 1997). Green and woody plants required continuous care and regular monitoring because the plants are easily susceptible to various diseases (Ebbels, 2003). Fungi, bacteria, viruses, worms and insects are among the

health-damaging agents that interfere with these plants. Normally, trees are planted in urban areas which are also prone to the problems of vandalism. These problems occur as a result of the irresponsible behavior of humanity, such as cutting down trees and branches, plucking leaves and others. If these problems are not identified and solved in advance, they will potentially cause harm to consumers, especially on public safety.

Besides that, tree care in urban areas should be carried out carefully in accordance with the schedule and time management that have been set by the Department of Landscaping and Maintenance in a city. It is important to improve the health of the trees and the aesthetic values of the city (Mojiol, 2001). Some action can be taken to reduce the risk of harms and maintain these plants regularly including lopping branches or damaged parts, having a good drainage system and also spraying insecticides and fungicides on trees. Therefore, tree health assessment should be done regularly if the area is frequently hit by storms or heavy rains so as to ensure that the tree care method is good and effective (Lonsdale, 1999).

This study thus aims to identify the trees that could potentially be risky in terms of health in the city of Kota Kinabalu, and to give suggestions regarding measures that are appropriate for the maintenance of trees at risk.

METHODOLOGY

Study Area

The locations of the study site are around the Kota Kinabalu city which are divided into five zones. A detailed inventory has been done at the site. The documentation and recognition process of the trees have been done by marking the trees on the site. The zones are divided by the total density of the trees in every zone, and the zones have been divided by Zon 1 which is KK Lama (Jalan Gaya) and Jesselton Point, Zon 2 is the Australian Place (Lorong Dewan), Padang Merdeka and Bandaran Berjaya, Zon 3 is the Segama, Wisma Merdeka, Wisma Sabah and Suria Sabah, Zon 4 is the Bangunan DBKK, Mahkamah, Lintasan Deasoka, Taman City Park and Taman Chong Thien Vun, and Zon 5 is the Pejabat Pos, Bank Negara, KK Plaza and Pasar Besar.

The tree health assessment is conducted to every main tree in the Kota Kinabalu city. The main trees that have been assessed are any woody plants and of height more than 5 meters which would include shaded plants, ornamental and heritage trees that have been planted by the Dewan Bandaraya Kota Kinabalu (DBKK). The assessment has been done in the field, and also by assessing through the picture of the trees. Recognition process has been done by examining the roots, trunks, branches and leaves. The soil conditions are also considered by observing its porosity.

Sampling method

Firstly, the collections of site information have been done through primary and secondary data. Primary data are obtained from the information on the tree assessment form while secondary data are obtained from the previous study carried out in Kota Kinabalu city and also information from DBKK. The survey is conducted around the study area to recognize the main tree species which are involved in the tree health assessment. Valuation of tree assessment method is used in data collection. Data collection is done by observing, recognizing the tree species, recording and listing important information about the tree criteria, health, planting site condition, risk target, tree infection, skewness, the level of danger and regulatory recommendation. The data are recorded and entered into the Microsoft Office Excel, and the percentage of the damage and tree condition will be analyzed.

RESULTS AND DISCUSSIONS

Tree Species at the 5 Zones in City of Kota Kinabalu

There were five zones that were set for the tree health inventory in Kota Kinabalu city. The total number of trees at these five zones were 688 trees and consisted of 23 tree species. The most dominant tree species planted in Kota Kinabalu was the *Pterocarpus indicus* which was also called as pokok angsana. Compared to 239 *Pterocarpus indicus* (pokok angsana), there was only 1 *Acacia auriculiformis* (Akasia) which was planted in the Kota Kinabalu. Based on the inventory, Zone 4 had the most number of trees, that was 192 trees or 28%, meanwhile Zone 1 with only 65 out of 688 trees or 9% was the zone with least planted trees (refer to Table 1).

Table 1: The number of trees and tree species at the 5 zones in the city of Kota Kinabalu.

Zone	Location	Tree Species name	Number of tree	Total
Zone 1	Kk Lama (Gaya Street) Jesselton Point	*Cassia fistula* (Rajah kayu)	11	65
		Pterocarpus indicus (Angsana)	14	
		Lagerstroemia indica (Bungor)	3	
		Cinnamomum iners (Kayu manis)	16	
		Khaya senegalensis (Mahogani)	6	
		Cebera odollam (Pong-pong)	9	
		Mimosup elengi (Tanjung)	6	
Zone 2	Australian Place Padang Merdeka Bandaraya Berjaya	*Pterocarpus indicus* (Angsana)	107	139
		Samanea saman (Hujan-hujan)	12	
		Fragrea fragrans (Tembusu)	6	
		Magnifera indica (Mangga)	2	
		Pithecellobium dulce (Madras thorn)	4	
		Cinnamomum iners (Kayu manis)	7	
		Delonix regia (Semarak api)	1	

Zone 3	Segama	*Pterocarpus indicus* (Angsana)	85	141
	Wisma Merdeka	*Acacia auriculiformis* (Akasia)	1	
	Wisma sabah	*Cassia fistula* (Rajah kayu)	1	
	Suria Sabah	*Cebera odollam* (Pong-pong)	9	
		Terminalia cattapa (Ketapang)	1	
		Khaya senegalensis (Mahogani)	29	
		Ficus sp. (Beringin)	5	
		Mimusop elengi (Tanjung)	10	
Zone 4	DBKK Building	*Lagerstroemia indica* (Bungor)	6	192
	Court	*Delonix regia* (Semarak api)	33	
	Lintasan	*Tabebuia rosea* (Pokok pui)	27	
	Deasoka	*Cebera odollam* (Pong-pong)	12	
	City Park	*Casuarina equisetifolia* (Cemara angin pantai)	2	
	Chong Thien	*Bauhinia* (Tapak kuda)	5	
	Vun Park	*Polyalthia longifolia* (Mempisang)	18	
			7	
		Fragrea fragrans (Tembusu)	8	
		Andira inermis (Brown-heart)	33	
		Pterocarpus indicus (Angsana)	21	
		Cinnamomum iners (Kayu manis)	6	
		Terminalia cattapa (Ketapang)	5	
		Mesua ferrea (Penaga lilin)	9	
		Cassia fistula (Rajah kayu)		
Zone 5	Post Office	*Cebera odollam* (Pong-pong)	25	151
	National Bank	*Delonix regia* (Semarak api)	5	
	Kk Plaza/	*Peltophorum pterocarpum* (Batai laut)	49	
	Pasar Besar	*Cassia fistula* (Rajah kayu)	26	
		Mimusop elengi (Tanjung)	21	
		Syzygium aromaticum (Chengkeh)	3	
		Ficus sp. (Beringin)	3	
		Samanea saman (Hujan-hujan)	5	
		Lagerstroemia indica (Bungor)	14	

Based on the health assessment of the five (5) selected zones about 688 of trees had been evaluated. Twenty three potential trees species had been identified during the study. There were many functions of the trees, such as decrease the air pollution, for beauty and aesthetics value, reduce the temperature, wind barrier, wildlife habitat, avoid or decrease the landslide occurrence and many more (Mojiol, 2018). A healthy tree will effectively show its functions. Tree planting selection was important, and this selection process was needed so as to go through these aspects, such as types of tree, ability to adapt to the planting site, condition of the planting site, its functions to the site (Stuckey, 2009). Wrong tree planting selection can cause the decline of the tree health, failure to achieve the planting objectives, and also involved the maintenance cost.

Pathogen and Disease (Biotic)

There were nine (9) pathogen and disease detected on trees which were in the 5 zones of the city of Kota Kinabalu. The pathogens and diseases would include fungi, aphid, epiphytes, parasite, mushrooms, mosses, ants, termites, and whiteflies. These pathogens and diseases attacked on the part of trees such as roots, stems and twigs (refer to Table 2).

Table 2: The presence of pathogens and diseases on the trees at each zone in Kota

Zone	Type of Pathogen and Diseases	Quantity	Total infected
Zone 1	Epiphytes	2	6
	Parasites	2	
	Whiteflies	1	
	Ants	1	
Zone 2	Parasites	19	37
	Ants	15	
	Mosses	2	
	Epiphytes	1	
Zone 3	Ants	18	40
	Fungi	8	
	Aphids	5	
	Parasites	5	
	Epiphytes	4	
Zone 4	Ants	28	93
	Parasites	21	
	Epiphytes	18	
	Aphids	12	
	Mushrooms	7	
	Termites	7	
Zone 5	Ants	49	72
	Parasites	7	
	Epiphytes	6	
	Aphids	4	
	Mushrooms	3	
	Whiteflies	1	
	Termites	1	
	Fungi	1	

The inventory of this research had identified 593 out of 688 trees in the city of Kota Kinabalu were attacked by the pathogens and diseases. Based on the inventory at all five zones, the major infected tree caused by the ants were 111 out of 248 pathogens and diseases or 45%, followed by parasites (22%), epiphytes (12%), aphids (8%), fungi (4%), termites (3%), mosses (1%) and whiteflies (1%). These infections on the living trees which were caused by the pathogens and diseases, would affect the health of the trees at these urban sites.

Figure 1: Some of the pathogens and diseases were mushrooms, termites, aphid, fungi and parasites that had infected the trees in Kota Kinabalu. These might potentially cause the trees to rot and fell which could further lead to the potential risks at the public sites.

Some pest groups are better known than others simply because they are easier to see. Insects are frequently found on trees although many are casual feeders and not serious pests, and some are beneficial (natural enemies). Fungi are frequently seen on dead and decayed organic matter, but they may not necessarily be the primary cause of the symptoms observed. Most fungi in nature are saprophytes (living on dead or decaying tissue) and only a very small proportion are pathogenic. Insects and fungi are relatively easy to distinguish by direct observation, while the remaining pest groups are not. Several other living agents occur on trees, including mosses, lichens and epiphytes such as bromeliads, but these have only a superficial impact on tree health.

Tree Health

Tree health can be assessed by seeing the changes in the color of the leaves and the annual growth rate of trees. Usually the attack of pests can be seen in the leaves itself when the normal colour change to chlorotic and necrotic (Robert, 1996).

According to the study, almost half of the trees had been vandalized by humans. Examples of vandalism that had been done were the roots of the trees were tied, tree trunks were tapped, branches purposely fractured, and car accidents. There were also activities on collecting the Angsana's tree barks (*Pterocarpus indicus*) for medical purposes for some users which can also affect the tree's health.

Trees Growing Condition

The tree growing conditions would include the health of the trees itself. The assessment was done on the physical condition of trees. The condition of roots, trunks, branches and tree canopy had been assessed. Based on the assessment made, the annual growth of trees were mostly medium where the trees were still safe and in healthy conditions, but still required monitoring.

A total of 582 trees were in a medium growth. Condition of 'poor' tree growth was 95 trees which they required monitoring and may be hazardous to visitors of that area. In addition, only 11 trees were in a 'good' condition (refer to Figure 2 below).
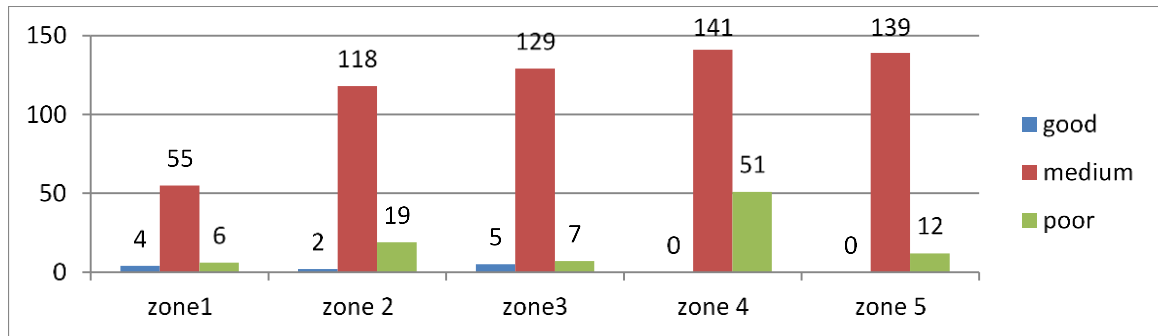

Figure 2: Graph of tree growing condition by zone.

The soil structure at the sampling station was compact which influenced the air content in the soil and the ability of the soil to store water. This could cause difficulty for the growth of the roots system and thus affected the tree growth (Mojiol and Maznah, 2000). The compacted soil was also unfertilized because of the limited nutrient content and organic materials.

Trees Infection

Infection of the tree would cause root rot and fungus infection. Based on the result of histogram in Figure 3 of the infection in trees, only three plants had a fungal infection, 12 trees had root rot, and over 673 trees were in 'normal' condition.
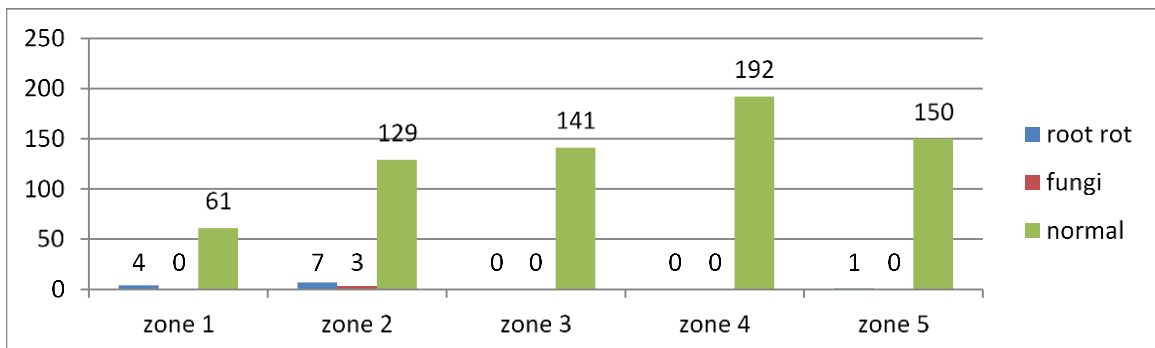

Figure 3: Graph of tree infection by zone.

In this study there were also three types of fungal attack detected on the 688 trees. The fungal attack can weaken the roots system by attacking the roots, and cause the tree to easily fall (Mojiol and Maznah, 2000). These fungal attack caused the tree's injury and it can formed 'cancer' which then caused the tree to decay, and it will lead to serious damages to trees in a long run, and might be dangerous to pedestrians. Other than that, insects were also one of the biotic factors that caused damage to the certain parts of the trees. For example, the leaf-eating insects showed the impacts toward the leaves. This can disturb the photosynthesis process. Overall, the annual growth rate of the trees in these study areas were moderate, but monitoring was still needed regularly. There were about 95 trees from the total of 688 trees which were in bad condition.

The Potential of Root Failures

The potential of root failure of roots was measured by assessing the situation and the ability to accommodate the roots of trees. The high level of failure would affect the tree to be fallen or death was high. Based on the graph, the potential failure of the root was low, and this showed that most of the trees were stable and of low potential to be felled. Only 21 trees had a high potential failure of roos, while 427 trees had a low potential for failure. In addition, 240 trees were in 'moderate' condition (refer to Figure 4).
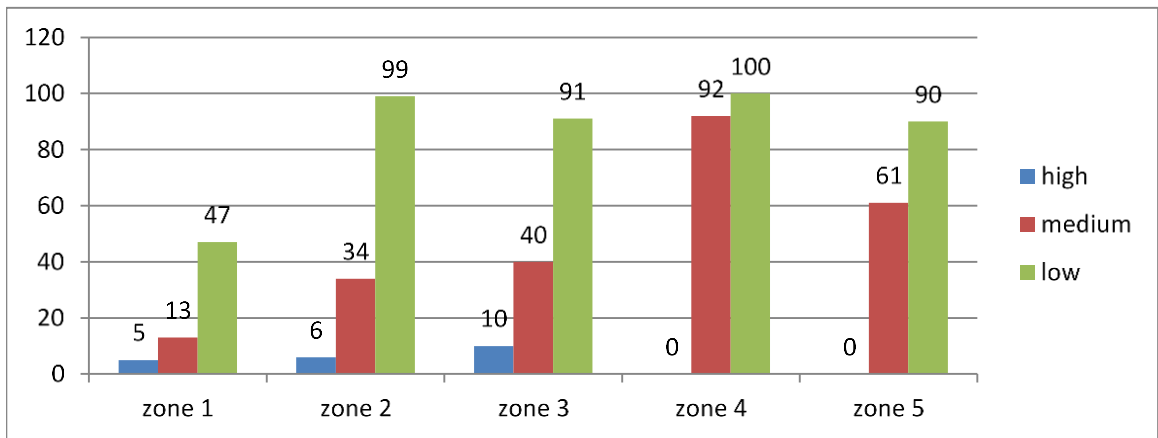
Figure 4: Graph of the potential of root failure.

Through this study, there were few maintenance steps to maintain the healthy condition of the trees so as to be able to survive at the planting site. Through the assessment, it showed that the maintenance was in good level, but needed improvement in techniques and efficiency; starting with tree selection based on the site conditions and its functions, followed by maintaining the young tree which had not formed a strong root system. Besides that, a support system should be built to help the young tree. Lastly, good pruning techniques should be applied to avoid any injury to the trees.

CONCLUSION

Based on studies of health assessments, it was found out that the trees in the study area of Kota Kinabalu city centre was still at a medium level of vigorous. In other words, the trees in this area were still in a better condition, but required observations from time to time so as to improve the health performances of the trees. A total of 593 trees from 688 trees were surveyed and examined during the study. Based on the assessment, a regular and efficient maintenance of these biotic problems can save these trees from potentially being infected by diseases.

As discussed earlier, good tree management practices was able to improve the health of a tree. If the maintenance steps were conducted correctly and regularly, deterioration of health problems will be manageable. Based on this study, it was found that trees in the study area were more vulnerable to the activities of vandalism, such as notch, hanging ads, and Angsana tree bark injury.

Awareness of users about tree care and health are needed to be implemented to bring awareness to them regarding the importance of trees in their daily lives, especially in urban areas traits. The presence of trees in urban areas would include various functions such as preventing wind, signage direction, lowering the temperature and many other functions which make trees as very valuable. A good healthy tree will work well, and so is vice versa. Awareness of tree health should be disclosed so as to reduce the principal cause of the failure. People now need to understand the concept of greening the earth, and they need to be more sensitive to the tree care and maintenance. The beauty of a tree depends on its health as well.

RECOMMENDATION

As a suggestion for future research, it should be more focus on the identification of pests and diseases that attack trees in urban areas, and method capable of controlling them. This study is very useful as a reference, and authority's awareness. The study survey on pests will make it easier for the authorities to address this issue, and plan their action for future tree management.

ACKNOWLEDGEMENTS

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