Mapping of Tree Damage Classification in The Western Part of Medan City Green Belts Using Geographic Information System

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Abstract. The existence of trees in the cities is very important. Trees play an important role as an absorber of CO_2 and a storage facility for carbon (C). This study aimed to classify and map the tree damage in the Western Part of Medan City Green Belts. The experiment was conducted using the Forest Health Monitoring (FHM) and the classification of tree damage classes was determined based on the scoring of index values based on USDA Forest Service. The results showed that there were 46 very healthy trees, 976 healthy trees, 1114 lightly damaged trees, 167 medium trees and 9 dead trees. The level of tree damage was dominated by the lightly damaged trees class. If the health of the tree is well preserved, then the tree can perform its function properly. Therefore, it is necessary to carry outthis research to provide important information about the damage of the trees then it can be used as a reference for the proper trees care activities.

1. Introduction

Medan City is the third largest city in Indonesia. As a metropolitan city, Medan experiences constant transportation activity. Therefore, the existence of trees in the cities is extremely important. Trees have the ability to reduce air pollutants [1].One of the city government efforts to create comfort in Medan City is to build a green belt along the main and secondary roads. The green belts were located either along the edges or median strips of roads or solely along the edges of the road. Green belts along median strips function to assist steering along the road, to assist forming views and restricting glare from other vehicles; those on the edges of roads serve as pollution-absorbent, shade-providing and noise-cancelling barriers as well as wind breakers [1-5]. The primary requirements for landscaping plants in streets as stipulated by the Regulation of the Ministry of Public Works (1996) No. 033are (1) their roots do not damage the road construction, (2) they are easy to maintain, (3) their stems and branches are not easily broken, (4) their leaves do not easily shed and (5) they are safe and offer comfort to motorists and other road users[1].

The trees need to be maintained and should be detected early by knowing the level of damage assessed in terms of damage types, damaged tree location and severity of damage. Early detection allows treatment of unhealthy trees to minimize damage to trees and avoid accidents caused by tree falling [6].The decrease in tree quality is predicted due to air pollution, human activity, biological factors and increasing age of trees. Decrease in quality can be observed from the level of damage

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suffered by the constituent trees. Damages can be caused by diseases, insect pests, weeds, fire, weather, animals and human activities [6].

Tree damage classification in the Western Part of Medan City Green Belts can implement Mangold modification concept [6]. Trees as the main object of the composition of green belt are expected to be guaranteed its health to provide a sense of security and comfort for the community. Thetree damage in the Western Part of Medan City Green Belts can be presented in the form of maps using Geographic Information System (GIS) technology. The GIS is a system-oriented operation relating to the conventional collection, storage and manipulation of referenced geographical data by computers (hardware and software) capable of handling this data. Among other functions of such mapping is the capacity to show the spatial distribution of geographical phenomena, including the nature and characteristics of their different positions on the surface of the earth [7]. GIS system can be developed a multi techniques and used to compared the field trees mapping survey result accuracy, not just for display a map field data survey result only[8,9]. The model can be develop using another indirect factor such as pixel and whole tree scale, vegetation index, AVIRIS or NDVI statistical analysis[10].

Since information regarding the tree damage in the Western Part of Medan City Green Belts is lacking, conducting this research is of great importance. This study aimed to classify and map the tree damage in the Western Part of Medan City Green Belts. This study is expected to provide information that will assist the government in Medan City in determining a management plan for the environmental development of Medan City.

2. Materials and Methods

This study was conducted from April to October 2016 in the Western Part of Medan City Green Belts. This research was conducted in 11 main roads that were located in five sub-districts, namely: Medan Barat, Medan Baru, Helvetia, Medan Petisah and Medan Sunggal (**Figure 1 and Table 1**).

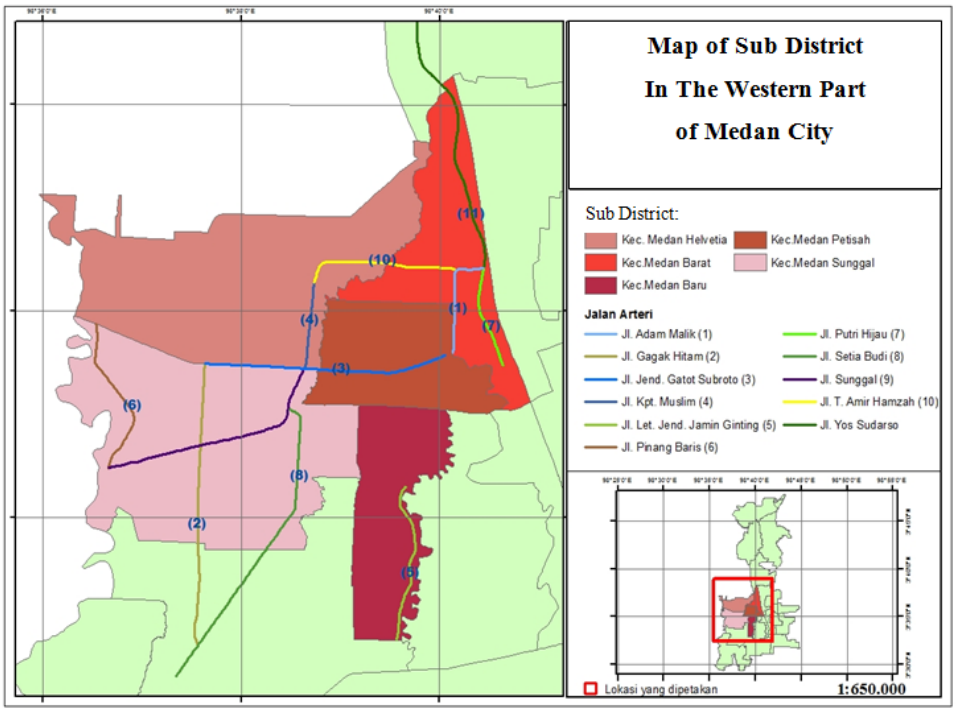


Figure 1. Study site map

Table 1. Name of the road at five sub district in WesternPart of Medan City

No.	Road name	Sub district
1	Jl. Gagak Hitam	Medan Sunggal
2	Jl. Pinang Baris	Medan Sunggal
3	Jl. Sunggal	Medan Sunggal
4	Jl. Setia Budi	Medan Sunggal
5	Jl. Yos Sudarso	Medan Barat
6	Jl. Tengku Amir Hamzah	Medan Barat
7	Jl. Putri Hijau	Medan Barat
8	Jl. Adam Malik	Medan Barat
9	Jl. Kpt. Muslim	Medan Helvetia
10	Jl. Jend Gatot Subroto	Medan Petisah
11	Jl. Let.Jend. Jamin Ginting	Medan Baru

The green belts for each sub-district of Medan City were determined using a purposive sampling technique. A tree inventory was compiled for all tree species (via a census method) located in the selected green belts. The GPS was used to record the coordinate points of the trees and GIS was used to analyse the distribution of the tree damage in green belts [11].

The experiment was conducted using the Forest Health Monitoring (FHM), which is monitoring forest stand conditions to analyse the present and the future, and provide recommendations for improving management. The classification of tree damage classes was determined based on the scoring of index values [12]. The 12 codes and damages type, 10 codes and locations of damage, 10 codes and classes of severity of damage and weights of tree damage index also refers to index values [12].

Damage assessment used criteria based on the FHM method [6,13,14]. Data obtained from the damage assessment was calculated by Damage Index Value (DIV) with the code and the weight of the DIV. Damage assessment calculation (1) used criteria based on previous study [6,13,14],namely:

$$DIV = \sum_{i=1}^{n} (\mathrm{Xi.\,Yi.\,Zi}) \qquad (1)$$

Where:
DIV : Damage Index Value at the tree level
Xi : The weight value on the type of damage
Yi : The weight value on the part / location of the damaged tree
Zi : The weight value on the severity of the damage

The class of damage for the tree based on the weight of the index value with the following criteria: healthy class: 0 - <5, class of lightly damage: 6 – 10, medium damage class: 11-15, and class of heavy damage: 16 -> 21.The final calculation results (DIV) was classified as: healthy class, lightly class, medium class and heavy class.

3. Results and Discussion

The tree species found on the study site were 13 species (Table 2), with 2,313 numbers of individual trees. *Pterocarpus indiscus* was the dominant tree species found in the study site (54.71%) in accordance to the resultsofprevious study [11,15], followed by *Swietenia macrophylla* (20.66%) and *Swietenia mahagoni* (17.59%).

Table 2. Tree species found at the study site

No.	Name of tree	Scientific name	Number of tree	Percentage
1	Angsana	*Pterocarpus indiscus*	1264	54.71%
2	Mahoni	*Swietenia mahagoni*	407	17.59%
3	Mahoni daun lebar	*Swietenia macrophylla*	478	20.66%
4	Mangga	*Mangivera indica*	9	0.39%
5	Tanjung	*Mimusops elengi*	9	0.39%
6	Glodokan	*Polyalthia longifolia*	60	2.59%
7	Sengon	*Paraserianthes falcataria*	1	0.04%
8	Melur	*Podocarpus elongates*	1	0.04%
9	Petai cina	*Leucaena leucocephala*	7	0.30%
10	Saga	*Adenathera pavonina*	14	0.61%
11	Asam jawa	*Tamarindus indica*	55	2.38%
12	Beringin	*Ficus benjamina*	3	0.13%
13	Waru	*Hibiscus tiliaceus*	4	0.17%
Total			**2313**	100.00%

There are 10 types of damage from 13 types of damage proposed by previous study [6]. Of the 10 types of damage (**Figure 2**), the most common type of damage was vandalism (34%), due to research conducted in urban areas with many advertising activities, such as: sticking banners using nails or wire. The result is in contrast to previous study [16] which found that the most damage type was further decay of the trees. This is because the research was conducted in the Bogor Botanical Gardens where the trees were old.

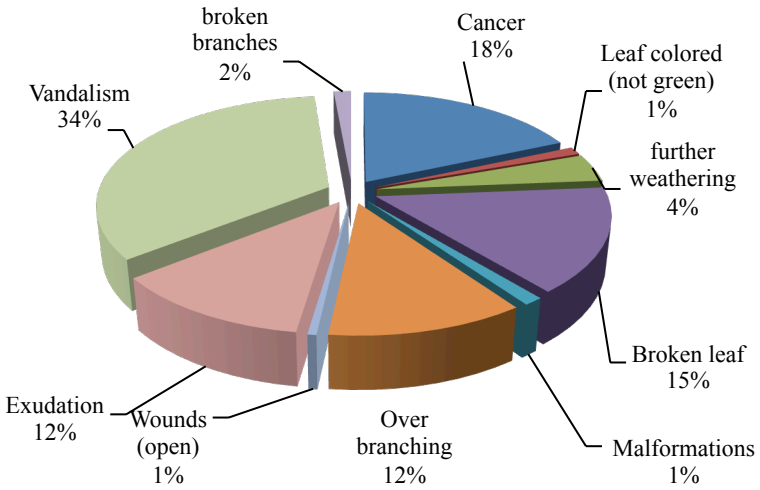


Figure 2. Percentage of damage type

The percentage of tree damage types can be observed in **Figure 3**. A total of 2,312 individual trees on 11 arterial roads found in 5 sub-districts in Medan City, the most affected part of trees was on the bottom of stem (41%), because it was easily accessible to humans. In contrast to previous study [16], the most commonly found tree parts are in the root and stump part, because many trees were old and easily fallen.

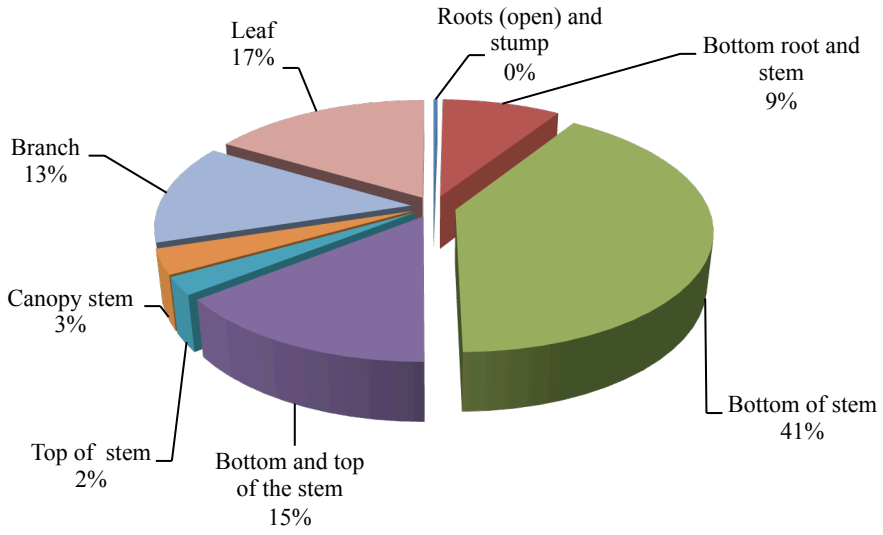


Figure 3. Percentage of damage location

There were three tree damage classifications in the WesternPart of Medan City Green Belts, namely: healthy, lightly damaged, and medium trees. Heavy damage classification was not found in the western part of Medan City Green Belts (**Table 3**). *Pterocarpus indicus*was dominant tree in the study sites (1,232 individual trees). A total of 655 individuals were classified as lightly damage. A total of 455 individuals were healthy and 107 individuals trees were classified as medium.

Table 3. Damage classes based on tree types

No	Name of tree	Very healthy	healthy	lightly	Medium	Heavy	Dead	Number of trees
1	*Pterocarpus indiscus*	8	455	655	107	-	7	1232
2	*Swietenia mahagoni*	13	175	219	32	-	-	439
3	*Swietenia macrophylla*	22	258	180	16	-	2	478
4	*Mangivera indica*	-	7	2	-	-	-	9
5	*Mimusops elengi*	-	4	3	2			9
6	*Polyalthia longifolia*	3	33	21	3	-	-	60
7	*Paraserianthes falcataria*	-	-	-	1	-	-	1
8	*Podocarpus elongates*	-	-	1	-	-	-	1
9	*Leucaena leucocephala*	-	1	5	2	-	-	8
10	*Adenathera pavonina*	-	3	9	2	-	-	14
11	*Tamarindus indica*	-	36	17	2	-	-	55
12	*Ficus benjamina*	-	2	1	-	-	-	3
13	*Hibiscus tiliaceus*	-	2	1	-	-	-	3
Total		46	976	1114	167	0	9	**2312**

Based on FHM criteria, there were 976 healthy trees, 1114 lightly damaged trees, and 167 medium trees. The Percentage of Damage Class can be observed in **Figure 4** while Map of Tree Damage Distribution on 11 arterial roads in Five Sub District in Medan City can be observed in **Figure 5**.

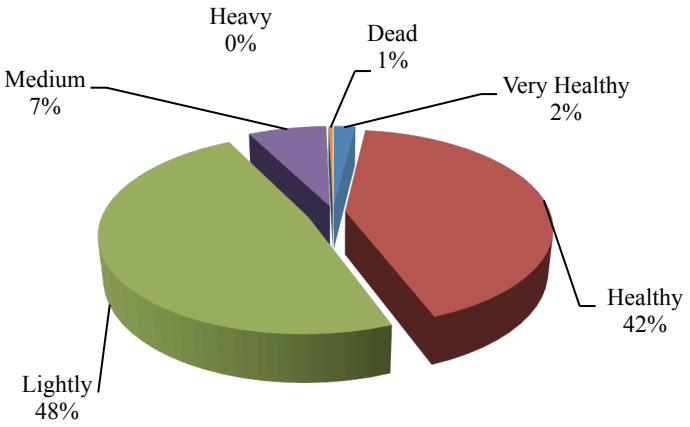


Figure 4. Percentage of damage class

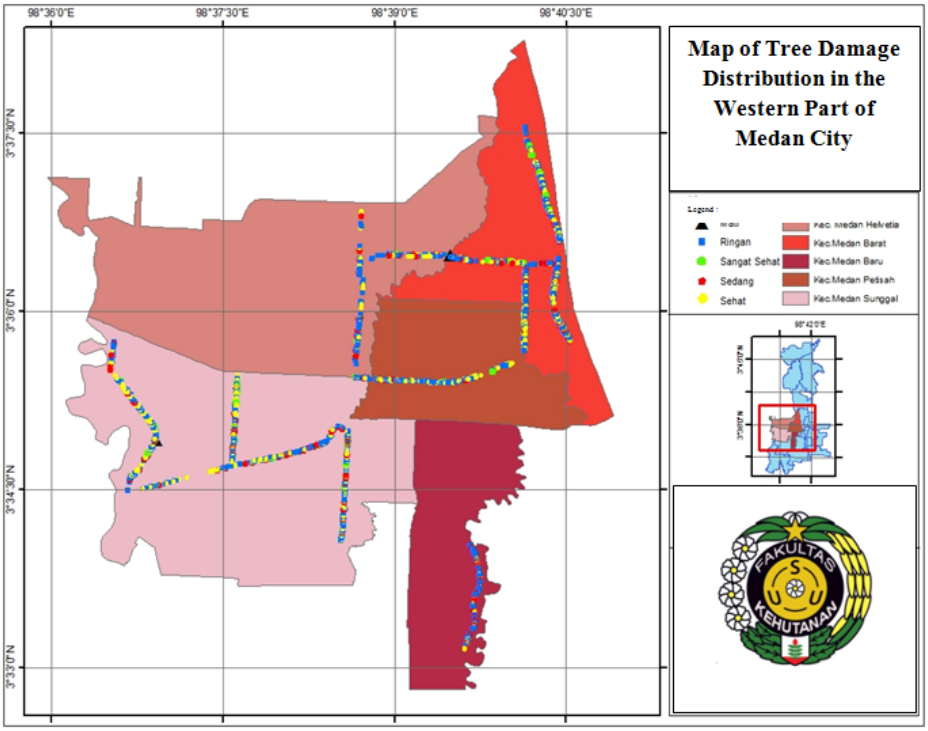


Figure 5. Map of tree damage distribution on 11 arterial roads in five sub district in Medan city

The level of tree damage was dominated by the lightly damaged trees class (**Table 3 and Figure 5**).Based on these conditions, it will require intensive maintenance, such as watering and trimming. Another thing that that should be a concern in the area was vandalism (destructive trees) that was commonly found in the trees along the western part of Medan City Green Belts.

4. Conclusion

There were three tree damage classifications in the Western Part of Medan City Green Belts, namely: healthy, lightly damaged, and medium trees. Heavy damage classification was not found in this location. The level of tree damage was dominated by the lightly damaged trees class. The most common type of damage was vandalism and most damage locations were found on the bottom of the stem.

Acknowledgement

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