The damage profile of kerai payung (*Filicium desipiens*) in University of Sumatera Utara green space based on Forest Health Monitoring (FHM) method

A Susilowati¹,³, A G Ahmad¹, H Siburian¹, A H Iswanto¹,³, H H Rachmat², A Zaitunah¹,³, Samsuri¹,³, F G Dwiyanti⁴ and I M Ginting¹

¹ Faculty of Forestry, Universitas Sumatera Utara. Jl. Tridharma Ujung No.1, Kampus USU, Medan 20155, Indonesia
² Forest Research and Development Center, Ministry of Environment and Forestry. Jl Raya Gunung Batu, Bogor, West Java 16118, Indonesia
³ JATI-Sumatran Forestry Analysis Study Center, Universitas Sumatera Utara. Jl. Tridharma Ujung No.1, Kampus USU, Medan 20155, Indonesia
⁴ Department of Silviculture, Faculty of Forestry and Environment, Institut Pertanian Bogor (IPB University), Jl. Ulin, IPB Dramaga Campus, Bogor, West Java 16680, Indonesia

E-mail: arida.susilowati@usu.ac.id

Abstract. The University of Sumatera Utara (USU) campus in Medan is a green space area with numerous social and environmental benefits. In the USU campus, trees were planted for providing inhabitant needs such as fresh air, pollutant absorber, medicine, wood, fuel, fiber, aesthetic, and food. One of the medicine, wood, and aesthetic species that grows on the USU campus is kerai payung (*Filicium desipiens*). Along with fallen trees and broken branches incidents, detection of kerai payung trees damage in the campus USU was needed to prevent undesirable incidents and provide recommendations for maintenance. This research aims to get information on the distribution and damage profile of Kerai payung. To determine and assess the damage profile, the Forest Health Monitoring (FHM) approach was used. Research showed that the Kerai payung diameter structure ranges from 8 cm to 74 cm. Based on FHM, damage types of Kerai payung trees in USU campus are as follows; broken or dead branch, open wound, brum branch, loss of dominant tips, leaves change color and konk. While the damage location is found in branches, buds and tips, lower and upper bole, leaves and upper bole. Our research pointed out that maintaining activities still be needed to avoid further damages.

1. Introduction

The urban green space (UGS) is important, especially in urban areas, because it plays a significant role in providing biophysical functions and a wide range of ecological values [1, 2] while contributing a socio-cultural role in improving the life quality in cities [3]. One of the urban green space types is the University campus. The University campus, as part of the urban green space, should not only focus on academic buildings, but also on absorbing heat, decreasing street noise, absorbing dust, aesthetics, and serving as a habitat for birds and other animals [4]. These functions will be achieved if supported by the proper selection of plants or tree species [5].
The USU campus, which occupies 120 hectares and includes both academic and non-academic zones, is located in the city of Medan [6]. USU's commitment to adopt the green space principles and preserving the environment. This commitment is also proven by getting ranked 11th from the University of Indonesia (UI) Green Metric in December 2020. There are around 121 tree species in the USU campus that are selected for planting with various purposes [7]. One of the tree species that abundantly grows and has many benefits on the USU campus is Kerai payung.

*Filicium decipiens* or kerai payung belongs to the family Sapindaceae and is known as a wood producer, medicine source [8], bioherbicide [9], and aesthetic [10]. Kerai payung is an evergreen tree species and can grow in different soil characters [4]. Morphologically kerai payung has compound and very large leaves arrangement, with 12 to 16 leaflets in a leaf. Kerai payung is an evergreen, slow grower tree with a height that can reach 35 feet. The species often planted in roadsides or gardens as a noise barrier are dangers posed by synthetic chemicals in ornamental and windbreak plants [8]. On the USU campus, commonly, kerai payung trees were planted in the parking area and on the roadside. The frequent broken branches incidents and the fallen trees indicate that kerai payung trees are not healthy. Therefore, it is necessary to evaluate the health condition of the kerai payung trees in our campus.

The health level of a tree or group of trees results from the interaction between trees and biotic and abiotic environmental factors. Under certain conditions, the interaction with environmental factors can cause damage. According to FHM [11], the quality of tree stands needs to be examined periodically to see what treatment needs to be given so that the trees are always in good condition. In line with these considerations, this study aims to determine the damage profile of kerai payung trees on the USU campus so that the maintenance strategy can be introduced for this species.

### 2. Materials and methods

The damage profile of kerai payung was observed through field inventory methods at 120 hectares of the USU campus area. The USU campus is located in Medan City, at an altitude of 2.5-37.5 m asl. Temperatures range from 23.2°C to 24.3°C for the minimum and 30.8°C to 33.2°C for the maximum. The average air humidity is between 84 and 85 %. The average wind speed is 0.48 m/sec, with a total evaporation rate of 104.3 mm per month and an inceptisol soil type. Approximately 191 kerai payung trees were identified and measured on health condition from canopy part into root. The Global Positioning System (GPS) was used for the coordinate marking to check and describe the distributions (figure 1).

![Figure 1. Kerai payung distribution in USU Campus.](image-url)
The methods are divided into recording the damages and physical tree condition measurement. The Forest Health Monitoring (FHM) methods [12] were used for recording the symptoms and signs. The field inventory method is performed by observation and measurement of visual symptoms and all kerai payung morphological and physical conditions. Forest Health Monitoring (FHM) is a method that can be used for intensive monitoring and assessment of ecosystem health conditions. The ecological indicators assessed are biodiversity, site quality, productivity, and tree vitality. Tree vitality indicators include tree damage conditions and canopy conditions. The tree damage condition is calculated based on the location (table 1), type of damage and severity (table 2). Damage to trees is estimated using damage assessment criteria. The damage location can be described in figure 2.

![Figure 2. The damage location according to FHM methods [12].](image)

**Table 1.** The code and damage location based on FHM methods [12].

| Code | Damage location                                      |
|------|------------------------------------------------------|
| 0    | No damage                                            |
| 1    | Root (open) and bole (30 cm high from border)        |
| 2    | Root and lower part of bole                          |
| 3    | lower half of the trunk between stump and base of the live crown |
| 4    | Lower and upper part of bole                         |
| 5    | Upper part of bole (the upper half of the stem between the stump and the base of the living canopy) |
| 6    | Main stem with live crown area                       |
| 7    | Branch                                               |
| 8    | Bud and shoot                                        |
| 9    | Foliage                                              |

**Table 2.** The damage codification according to FHM methods [12].

| No  | The damage type                  | The severity level (10% - 99%) | Code |
|-----|----------------------------------|---------------------------------|------|
| 1   | Gall/cancer                      | 20%                            | 1    |
| 2   | Konk/decay further               | Nil*                           | 2    |
| 3   | Open wound                       | 20%                            | 3    |
| 4   | Gammmosis and resinosis          | 20%                            | 4    |
| 5   | Broken of branches less than 0.91 cm | Nil*                     | 11   |
| 6   | Brum in bole and root            | Nil*                           | 12   |
| 7   | Broken and dieback of root less than 0.91 cm | 20%                     | 13   |
| 8   | Crown dieback                    | 1%                             | 21   |
| 9   | Broken and died bracch           | 20%                            | 22   |
| 10  | Brum in crown                    | 20%                            | 23   |
| 11  | Leaf damage                      | 20%                            | 24   |
| 12  | Leaf discolorization             | 30%                            | 25   |
The types of damage observation and measurement were carried out in detail and thoroughly on all parts of the tree from the roots to the crown (table 2). Every damage found, is recorded at a maximum of three times at the same location. If there are many damages in one location, then the most severe damage is used for analysis. After all the damage data and the damage location are obtained, further analysis is carried out.

3. Result and discussion
There are 243 kerai payung trees on the USU Campus and scattered in several locations. The kerai payung were found in nine locations, namely the Auditorium, Faculty of Engineering, Faculty of Agriculture, Faculty of Mathematics and Natural Sciences, Faculty of Economics, Faculty of Social Sciences and Politics, Faculty of Law, Faculty of Cultural Sciences, and Archives building. The diameter structure of kerai payung trees that grow on this location ranged from 8 cm to 74 cm. For profile of damage, damage type and damage location approach were used.

3.1. Damage type
The tree health assessment is a method of observing symptoms and indicators that occur naturally and are related to tree health. The types of damage that occur to trees are usually particular and have a specific value and various effects on the tree condition [6]. As it is known that every type of tree damage will impact the physiological processes. The damage specifically affects the decline in rates of growth, loss of biomass, unhealthy canopy conditions, and the most severe consequence is the death of trees [11]. There are 12 types of damage found on trees according to FHM, but only eight types of damage were found in kerai payung trees, those were broken or dead branches (figure 3a) of 167 trees (87.5%), open wounds (figure 3b) 123 trees (66.85 %), brum in branch or canopy (figure 3c) of 98 trees (53.26%), loss of dominant tip (figure 3d) of 47 trees (25.54 %), leaves change color (fig. 3e) 20 trees (10.87%), konk(figure 3f) 14 trees (7.61%) and brum in root and stem (figure 3g) of 11 trees (5.98%). The least damage was found in leaf (fig.3h) as many as 2 trees (1.09%).

The broken or dead branch is the dominant damage type often found on kerai payung on the USU campus. The assessment result found as many as 167 trees (87.5%) experienced this damage. Damage that occurs in the twig, leaves, branches will result in an unhealthy canopy and indirectly interfere with photosynthesis. The high proportion of broken or dead branches on the USU campus may be caused by several diseases such as parasitic and non-parasitic pests [14], tight spacing, and wind [6]. Trees with
less tapered and broken branches tend to suffer blown by the wind easily. Thinning and wide spacing activities will produce good stems but are less susceptible to injury and brokenness than poor tapers [15]. Furthermore, [16] maintenance activities through tree branches pruning to a certain size, can create a lower center of gravity and help trees from wind damage. Reducing the canopy part will also lessen the potential for damage.

3.2. Damage location
There are nine damage locations according to FHM criteria. The damage locations related to the damage types. Based on the observation (figure 4), the damage locations of kerai payung trees are only found in five locations, namely the lower and upper bole as many as 137 trees (74.46%), the upper bole as many as 11 trees (5.98%), the branches of 161 trees (84.3%), the buds and tips were 78.8% (145 trees) and the leaves were 22 trees (9.05%).

![Figure 4. The five damaged locations of kerai payung trees in USU campus.](image)

The damage locations have different effects on the physiological processes of the trees. If damage occurs to the stem, the tree's growth will be disrupted because the stem is responsible for water transportation from the roots to the leaves. Damage of the trunk will increase the risk of the tree falling or broken. If damage occurs to the leaves, the physiological process severely disturbed photosynthesis. The general effect caused by damage to these leaves is the inhibition of the photosynthesis process as the main function of the leaf.

3.3. Maintaining recommendations
The various types of damage that attack the trees indicate changes in environmental factors. Both those biotic and abiotic factors harm trees. Damage that occurred on the tree becomes an indicator that marks the health condition of the tree. Tree damage will affect the physiological function of the tree, reducing the rate of tree growth and can cause tree death. Dead an individual tree becomes an important issue to be considered because it will lead to population decline. Tree damage can be caused by disease, pest attack, weeds, fire, weather, animals, or anthropogenic [15].

The assessment results of the damage profile on kerai payung indicate that maintenance is needed to prevent further tree damages. Maintenance is an activity required to take care of trees in green spaces to remain healthy. The high percentage of damage on the branch part can be reduced by doing branch pruning activities. In principle, pruning of damaged and dead branches is to ensure the safety of residents and for a more comfortable environment. Physiologically, pruning is required to improve the rate of photosynthesis [16] by increasing interception of light and promoting branches and shoots growth. Light interception is well acknowledged to have an important role in photosynthesis, product assimilation, and sink partitioning [17]. Tree care is required in the green area of the USU campus in order to maintain
the health of the trees and ensure the safety of campus inhabitants while also preserving the environment. Kerai payung maintenance activities for other types of damage can be carried out through general maintenance and special maintenance. General maintenance includes transplanting, fertilizing, pruning, treating wounds, filling tree holes, strengthening and preserving. While special maintenance includes tree diagnosis, pest and disease control, watering and damage control.

4. Conclusion
Based on the damage profile identification, the damage type of kerai payung trees in USU Campus are broken or dead branches (87.5%), following by open wounds (66.85 %), brum in branch or canopy (53.26%), loss of dominant tip (25.54 %), leaves change color (10.87%), konk (7.61%), brum in root and stem (5.98%) and leaf damage (0.82%). Meanwhile, the location is dominated by branches (84.3%), followed by buds and tips (78.8%), leaves (9.05%), lower and upper bole (74.46%), while the lowest one is upper bole (5.98%). Maintenance activities, especially branch pruning, are very necessary for kerai payung to minimize the negative impacts of broken branches.

5. References
[1] Czaja M, Kolton A and Muras P 2020 The complex issue of urban trees stress factor accumulation and ecological service possibilities Forests 11: 932
[2] Ferini F, Fini A, Mori J and Gori A 2020 Role of vegetation as a mitigating factor in the urban context Sustainability 12: 4247
[3] Jansson M 2014 Green space in compact cities: the benefits and values of urban ecosystem services in planning Nordic J. Archit. Res. 2 139-60
[4] Gulwadi G B, Mishchenko E D, Hallowell G, Alves S and Kennedy M 2019 The restorative potential of a university campus: Objective greenness and student perceptions in Turkey and the United States Landsc. Urban Plan. 187 36-46
[5] Ives C D, Lentini P E, Threlfall C G, Ikin K, Shanahan D F, Garrard G E, Bekessy S A, Fuller R A, Mumaw L and Rayner L 2016 Cities are hotspots for threatened species Glob Ecol. Biogeogr. 25 117-26
[6] Susilowati A, Ahmad A G, Silalahi V and Rachmat H H 2018 The detection and monitoring of the tree health of Swietenia macrophylla in University of Sumatera Utara’s campus area IOP Conf Ser: Earth Environ. Sci. 203: 012028
[7] Susilowati A, Rangkuti A B, Rachmat H H, Iswanto A H, Harahap M M, Elfati D, Slamet B, Ginting I M 2021 Maintaining tree biodiversity in urban communities on the university campus Biodiversitas 22 (5) 2839-47
[8] Paramaguru R, Jagadeswar K, Kumar C B M and Raj N A V 2011 Evaluation of anti-inflammary activity on the leaves of Filicium decipiens in experimental animal models J. Chem. Pharm. Res. 3 (3) 243-47
[9] Kairirunisa, Indriyanto and Riniarti M 2018 The potential of Terminalia cattapa, Swietenia macrophylla and Filicium decipiens leaf extract as Bioherbice on Cyperus rotundus L. Enviroscentiae 14 (2) 106-13
[10] Rajeswari R and Rajes S V 2015 GC-ms analysis on methanolic bark extract of Filicium decipiens. (wight & arm) thwaites World Journal of Pharmaceutical Research 4 (11)
[11] Supriyanto, Kenneth S, Soekotjo and Ngaloken G 2001 Forest health monitoring plot establishment. In Forest Health Monitoring to Monitor The Sustainability of Indonesia Tropical Rain Forest, Volume I (Bogor: SEAMEO BIOTROP)
[12] USDA Forest Service 1999 Forest Health Monitoring Field Methods Guide (Washington: USDA Forest Service)
[13] Mangold R 1997 Forest Health Monitoring: Field Methods Guide United States Department of Agriculture Forest Service Washington
[14] Nuhamara S T and Kasno 2001 Present status of crown indicator *In Forest Health Monitoring to Monitor The Sustainability of Indonesia Tropical Rain Forest, Volume I* (Bogor: SEAMEO BIOTROP)

[15] Putra E I 2004 *Pengembangan Metode Penilaian Kesehatan Hutan Alam Produksi* [Thesis] [Bogor: Bogor Agricultural University] 62 p

[16] Galinsky W 1989 A windthrow-risk determination for coniferous trees *Forestry* 62 139-46

[17] Petty J A and Worrell R 1981 Stability of coniferous tree stems in relation to damage by snow *Forestry: An Int. J. of Forest Research* 54 (2)