Tree risk identification, assessment and mitigation in Universitas Indonesia’s urban forest

E Pradipta¹, N Kholis¹, F Lestari¹ and A Bowolaksono¹,3
¹Occupational Safety Health and Environment Unit, Universitas Indonesia, Depok 16424, Indonesia
²Department of Architecture, Faculty of Engineering, Universitas Indonesia, Depok 16424, Indonesia
³Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Indonesia, Depok 16424, Indonesia

E-mail: alaksono@sci.ui.ac.id

Abstract. Trees can drop limbs that injure or even kill people, damage vehicles and infrastructure, especially during storms or extreme climate. They need some assessment and mitigation to prevent it. The Urban Forest and Green Open Space in Universitas Indonesia (UI) need mitigation strategies to reduce the risk of fallen trees. The preventive conducts of fallen trees, broken branches and stems (that possess ability) to cause accidents at the Universitas Indonesia, Depok were carried out through several activities. The result were descriptions of the trees management in UI e.g annual monitoring data of trees, visual mapping, availability of proper tools, standard operating procedures and regular potentially-hazardous trees pruning and/or elimination. Also human resources improvement to meet the environmental safety demand for the UI academia civitas e.g. staffs competency enhancement training and sharing activities (related with tree pruning) with other institutions or stakeholders.

1. Introduction

Forest is the source of all living creatures on Earth and has so many functions to maintain the sustainability of nature. Its role to provide oxygen, food, and shelter for many faunas including human, made it the most precious part of the Earth. Although only 30% of Earth surface are covered with land, earth still considered as a green planet for the existence of the forest throughout the land. But as the growth of human population keeps increasing exponentially every year, the need of space forced us to open more forest and convert it to living space. This condition damaged the forest and pushed the nature losing its balance and sustainability. Hence why so many disasters happened in the recent decade than before.

Fortunately, the awareness of people to get better life has developed a way to maintain the sustainability of nature by introducing a concept called urban forest. Urban forest is a network or system comprising of all woodlands, groups of trees, and individual trees which are located in urban and peri-urban areas [1]. It can be forests, street trees, and trees in the parks and gardens. Through the urban forest concept, it is possible to get more space for living space without damaging the sustainability of nature. But a new challenge comes from the hazard of fallen trees to the surroundings, including human activities. So, it is important to discuss the risk identification, assessment, and mitigation of trees in urban forest, especially in Universitas Indonesia’s urban forest.
2. Overview

2.1. Urban forest’s regulations in Indonesia

Urban forests in Indonesia are regulated by several laws, such as: Law number 1 of 1970 on Occupational Safety that mentions one of the safety requirements aspect is by preventing and reducing workplace accidents [2]; Law number 26 of 2007 on Spatial Planning that mentions the proportion of green open space in urban areas shall be at least 30 (thirty) percent of the total area of the city [3]; and Law number 32 of 2009 on Environmental Protection and Management that mentions one of environmental protection and management aims is to ensure the safety, health, and human life [4].

The government made a regulation on tree management around road network systems too. Its It is mentioned in the Regulation of The Minister of Public Works number 05 of 2012 on Tree Planting Guidance on Road Network Systems. It is mentioned that one of the objectives of maintaining and pruning trees in Indonesia is to eliminate potential hazards to the surrounding environment and road users [5].

2.2. Universitas Indonesia’s urban forest regulation

On October 31st, 1988, the Rector of Universitas Indonesia, Prof. Dr. Sujudi declared that Universitas Indonesia’s urban forest at Depok covered around 192 hectares from its total campus area of 320 hectares. This urban forest serves as vegetation collection and conservation area for trees around Indonesia and as Ciliwung’s watershed catchment area. The development budget of this urban forest is sourced from various related private agencies, government, and other non-binding resources [6].

Universitas Indonesia’s urban forest is regulated too by Jakarta Governoor’s decree that was issued in 1999 [7]. It is mentioned that Universitas Indonesia’s urban forest serves as conservation urban forest that consists of plants for various places such as Sumatra, Java, and Kalimantan. There are around 186 plants species that have been cultivated in Universitas Indonesia’s urban forest, and the enrichment programs are still ongoing.

3. Management of Universitas Indonesia’s Urban Forest

3.1. Structure of vegetation

Universitas Indonesia’s urban forest has tropical rainforest characteristics and divided into three advanced vegetation. They are vegetation from eastern part of Indonesia (East Wallacea), western part of Indonesia (West Wallacea), and original vegetation of Java. That classification objective is to create a mini forest of Indonesia, that consists of plants from all area in Indonesia.

Currently, Universitas Indonesia’s urban forest mostly consists of fast growing plant tree species, rubber plants (*Hevea brasiliensis*), and plants from Family Leguminoceae (acacia, sengon, etc.). It is possible too that many invasive plant species can be found in a lot of areas of Universitas Indonesia’s urban forest that comprised current vegetation composition. Enrichment programs that have been done since 1988 until now play their role too in forming current composition.

3.2. Identification and assessment

Tree risk assessment is a system to identify, analyze, and evaluate the risk of trees [8] [9]. This process started by identifying current situation and location of trees. It included identifying the trees species and their characteristics. After all of those information obtained, trees hazard were analyzed according to information gained. And then possible risks caused by trees were evaluated

Tree risk assessments are categorized based on time, training, and equipment requirements. There are three levels of assessments [9]:

• Level 1 “The limited visual assessment”
  Can be done by foot, with a vehicle, or from the air.
• Level 2 “A basic assessment”
  Is a ground-based visual inspection or assessment of a tree and its surroundings. The equipments for this assessment consists of diameter tape, clinometer, hypsometer, compass, soil probe, aerometer, binoculars, probe, camera, and hand trowel.
• Level 3 “An advanced risk assessments”
  Assessment with advanced tools or systems e.g aerial inspections, decay detection method and trees static/dynamic stability.

3.3. Mitigation activities
Mitigation activities are necessary to reduce the risk from trees to the surroundings, including towards human activities. But to create good mitigation planning, several aspects must be taken into consideration such as: policy and legal framework; planning, design and management; key monitoring criteria; key competencies/skills to be developed; the major knowledge gap that must be overcome; and helpful factual advocacy. By following these steps, mitigation activities towards tree risk can be done efficiently and effectively.

There are several mitigation activities that have been conducted in Universitas Indonesia’s urban forest. Based on the Annual Report of UPT K3L UI those activities are comprised of [10] [11]:
• Routine tree pruning,
• Trees mapping and identification,
• Trees management training as Universitas Indonesia’s staffs requirements,
• Making Standard Operating Procedure (SOP),
• Provision of tools that support tree management activities,
• Coordination and cooperation with forestry related agencies, and
• Control, supervision and elimination of potential hazards and enviromental risks

Human capital developments are needed to ensure all staffs who are in charge of trees management possess competent skills and requirements. Currently, there are eight staffs in Universitas Indonesia’s urban forest management team who hold international certification for handling and managing trees in urban and peri-urban areas, and around 20 staff who hold national certification for pruning and eliminating hazardous fallen trees. Several trainings were included as well for knowledge and skills enrichment toward the staff, such as aerial lift training and work above ground training.

3.4. Revegetation and nursery
Planting new plants is needed after tree elimination activities and Universitas Indonesia’s regulation has stated that the revegetation program was undertaken by planting several plants for every eliminated trees. The revegetation program was conducted within internal and external elements such as government and private agencies. Several revegetation activities that have been carried out were:
• Revegetation program with Mobil Oil in 1998,
• Revegetation program with Astra,
• Revegetation program with CIMB Niaga,
• Revegetation program by planting 4,000 trees with BNI in 2013,
• Revegetation program by planting 27,000 trees with Pertamina during 2013—2014,
• Revegetation program by planting 500 fruit seeds with ANTAM in 2014,
• Revegetation program by planting 1,000 trees with Kopassus in 2014,
• Revegetation program with Ritz Carlton in 2014,
• Tree planting programs with KLHK since 1988—2017,
• Regular planting by internal staffs and officers, with seedlings from KLHK or TNI,
• Provision of seedling for stock in Universitas Indonesia’s urban forest’s nursery, etc.

4. Results
Although the mitigation program and planning for tree risk have been done since 1988, advanced mitigation planning just began in 2015 and 2017 only. It was because special unit (Health and Safety Environment) in Universitas Indonesia for managing trees and urban forest was just established in 2014.

![Figure 1. Comparison of trees managed in 2015 and 2017.](image_url)

Based on the figure 1, it is displayed that an increase in the number of trees maintained in 2017 compared to data in 2015. While the number of incidents of fallen trees or broken branches in 2017 decreased compared to data in 2015. This indicated that the number of fallen trees incidents decreased by approximately 47% compared to data in 2015.

5. Discussions
Although activities for tree risk identification, assessment and mitigation programs have been conducted in this study, a lot of improvement should be projected afterwards following the result. Those improvements may include inspection methods and tools/systems to identify and assess the hazard of trees (fallen trees or broken branches). The issue was on limited access for using advanced technology and tools. Discussions, seminars and conferences on Urban Forest in Indonesia were still not a concern for government and private agencies. If those activities can be held, it can be used as platform to increase the attention and awareness on trees management trees throughout the city. Cooperated research and management about Urban Forest with related scientific fields are significant as well to gain more vast point of views about urban city and its prospect for better future life.

6. Conclusion
Innovation and improvement on urban forest management are needed for better future life and maintaining the stability and sustainability of the nature. Further research and management with related scientific fields are also necessary.
References

[1] Salbitano F, Borelli S, Conigliaro M and Chen Y 2016 Guidelines on urban and periurban forestry (Rome: Food and Agriculture Organization of the United Nations)

[2] Presiden Republik Indonesia 1970 Undang-undang No.1 tahun 1970 tentang Keselamatan Kerja (Jakarta: Sekretaris Negara Republik Indonesia)

[3] Presiden Republik Indonesia 2007 Undang-undang No. 26 tahun 2007 tentang Penataan Ruang (Jakarta: Menteri Hukum dan Hak Asasi Manusia Republik Indonesia)

[4] Presiden Republik Indonesia 2009 Undang-undang No. 32 tahun 2009 tentang Perlindungan dan Pengelolaan Lingkungan Hidup (Jakarta: Menteri Hukum dan Hak Asasi Manusia Republik Indonesia)

[5] Menteri Pekerjaan Umum Republik Indonesia 2012 Peraturan Menteri Pekerjaan Umum no.5 tahun 2012 tentang Pedoman Penanaman Pohon pada Sistem Jaringan Jalan (Jakarta: Menteri Hukum dan Hak Asasi Manusia Republik Indonesia)

[6] Rektor Universitas Indonesia 1988 Keputusan Rektor Universitas Indonesia No. 084/SK/R/UI/1984 tentang Penetapan Lahan Penghijauan Kampus Baru Universitas Indonesia sebagai Areal Pembangunan dan Pengembangan Hutan Kota UI (Jakarta: Universitas Indonesia)

[7] Gubernur Kepala Daerah Khusus Ibukota Jakarta 1999 Surat Keputusan Gubernur Kepala Daerah Khusus Ibukota Jakarta No.3487/1999 tentang Penetapan Hutan Kota Universitas Indonesia (Jakarta: Daerah Khusus Ibukota Jakarta)

[8] Dunster J A, Smiley E T, Matheny N and Lilly S 2013 Tree Risk Assessment Manual (Champaign: International Society of Arboriculture)

[9] Koeser A K, Hauer R J, Klein R W and Miesbauerd J W 2017 Assessment of likelihood of failure using limited visual, basic, and advanced assessment techniques Urban For. Urban Green. 24 71-79

[10] Kepala UPT K3L UI 2015 Laporan Kinerja Unit Pelaksana Teknik Keselamatan, Kesehatan Kerja dan Lingkungan (UPT K3L) Universitas Indonesia 2015 (Depok: UPT K3L UI)

[11] Kepala UPT K3L UI 2016 Laporan Kinerja Unit Pelaksana Teknis Keselamatan, Kesehatan Kerja dan Lingkungan (UPT K3L) Universitas Indonesia 2016 (Depok: UPT K3L UI)