NUSANTARA BIOSCIENCE
Vol. 13, No. 2, pp. 131-139
November 2021

ISSN: 2087-3948
E-ISSN: 2087-3956
DOI: 10.13057/nusbiosci/n130201

The suitability assessment of the tree species in the urban parks and urban forest in Kediri City, East Java, Indonesia

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Manuscript received: 20 January 2021. Revision accepted: 29 June 2021.

Abstract. *Afrianto WF, Wati SI, Hidayatullah T. 2021. The suitability assessment of the tree species in the urban parks and urban forest in Kediri City, East Java, Indonesia. Nusantara Bioscience 13: 131-139.* Kediri has several urban parks and an urban forest as green open space (GOS), which have essential roles in economical, social, aesthetical, and ecological aspects. Generally, urban trees provide ecosystem services, such as carbon sequestration, stormwater attenuation, energy conservation, habitat for wildlife, and air, water, and noise pollutants reduction. The present study aimed to (i) determine tree diversity in five urban parks and an urban forest in Kediri City and (ii) evaluate the suitability of tree species based on three indicators (silviculture, management, and aesthetic). This study was conducted in five urban parks and one urban forest in Kediri City. The suitability assessment was carried out through a literature review. The results showed that 29 tree species belonging to 17 families were found in the study sites, with the family Fabaceae being the most dominant one with five species. The number of exotic tree species (17) was higher than that of the native ones (12). The suitability assessment results showed that 21 tree species had a high score of 39-44, and only eight urban tree species had a medium score of 36-38. The urban parks and forests in Kediri were managed to conserve germplasm, recreation, and protection. Therefore, the shapes had to be clumped and lined. This study will contribute information to be used as guidance for urban tree management and policy framework.

Keywords: Suitability assessment, tree species, urban forest, urban parks

INTRODUCTION

Kediri is a city in East Java Province, Indonesia. The Kediri's by law (PERDA) No. 1 of 2012 states that the provision of total green open spaces (GOS) is approximately 1.268 ha or only 20% of the entire area. The Spatial Planning Law No 26, the year 2007, stipulates that the minimum GOS should be 30% (20% public and 10% private) of the total city area. Thus, Kediri City needs around 10% to reach the standard for minimum GOS area. The total GOS needed in an area can be measured by three variables, (i) population, (ii) location, and (iii) oxygen requirement (Ardani et al. 2013). For instance, according to the Minister of Public Works Number: 05/PRT/M /2008, the GOS needed should be based on the population, namely 20 m^2/individual (Fitri et al. 2020). In Kediri City, the GOS consists of urban parks and an urban forest. The GOS in Kediri is used by communities and the government for economic and social activities, such as a place for mobile libraries (Ningtyas 2019). Kediri's GOS is considered good based on the key performance indexes (ecological, economical, aesthetical, and social aspects) (Paulina and Murtedjo 2018).

Urban trees have essential roles such as economic, public health, visual, and aesthetic (Roy et al. 2012). In terms of ecosystem services, they are necessary for carbon sequestration, stormwater attenuation, energy conservation, habitat for wildlife, and reducing air, water, and noise pollutants (Hirokawa 2011; Roy et al. 2012; Roeland et al. 2019). High plant diversity in urban areas can be a bridge for humans to experience nature and wildlife (Jasmani et al. 2015). The urban trees also contribute to two points of Sustainable Development Goals (SDGs), which are 15 (life on land) and 17 (partnerships for the goals) goals (Turner-Skoff and Cavender 2019).

Besides the total areas of GOS, urban tree species selection is an essential aspect of urban green area management. The urban tree species should be selected according to growing requirements so the planted trees can grow and function optimally (Mukhlison 2013). Furthermore, the standard of urban tree selection can be used to optimize the infrastructure development benefits (Núñez-Florez et al. 2019). Moreover, urban trees should generally tolerate environmental stress and meet silviculture, management, and aesthetic indicators (Sæbø et al. 2005). Urban parks and an urban forest in Kediri refer to urban green spaces with an area smaller than 4 hectares. Because of the limited area, the tree species diversity in the urban areas of Kediri City is low. This phenomenon will be a challenge for management because the diversity of tree species determines the resilience of urban parks and forests (Sjöman et al. 2012; Sjöman et. 2018). Therefore, this study aimed to (i) determine the tree diversity in urban parks and an urban forest of Kediri City and (ii) evaluate the suitability of tree species based on three indicators (silviculture, management, and aesthetic). This study will contribute information to be used as a management and policy framework for urban areas.

MATERIALS AND METHODS

Study area

This research was conducted by analyzing the tree species in five urban parks and an urban forest of Kediri City (coordinates 7°48′59.8″S 112°0′42.9″E), East Java, Indonesia (Figure 1). The total area of Kediri City is 63.40 km² divided into three sub-districts: Mojoroto, Kota, and Pesantren Sub-Districts. The location sampling sites there were (i) Kediri Square, (ii) Ngronggo Park, (iii) Sekartaji Park, (iv) Harmoni Park, (v) Kediri Memorial Park, and (vi) Joyoboyo Urban Forest. Those locations were chosen because these study sites are the existing GOS in Kediri (Sulistiyowati and Yuantika 2019).

Data collection

The data were collected with a rapid assessment of the field and a literature review from the previous researchers (Sulistiyowati and Yuantika 2019). The tree identified in the study sites were those with a diameter at breast height (DBH) of > 10 cm and a height of > 1.5 m. The tree species were divided into two categories: (i) native species, i.e., the species naturally distributed in Indonesia, and (ii) exotic species, i.e., those naturally distributed outside Indonesia.

Data analysis

The score of suitability was examined with the literature review analysis. The suitability of the tree species was analyzed through data processing, tabulation, and descriptive study. The class interval was determined through a formula from the highest score to the lowest score/total of classes. Components of evaluation to calculate the score of urban parks and urban forest vegetation were shown in Table 1 (Sæbø et al. 2005; Indriyanto 2006; Mukhlison 2013). Literature review through journals, the website CABI (www.cabi.org), and other scientific documents were used to examine all criteria assessment of the tree species. The suitability level was determined by calculating the score of all urban tree species found. The score was divided into three suitability levels, i.e. (i) Low (score 23-30), (ii) Medium (score 31-38), and (iii) High (score 39-46).

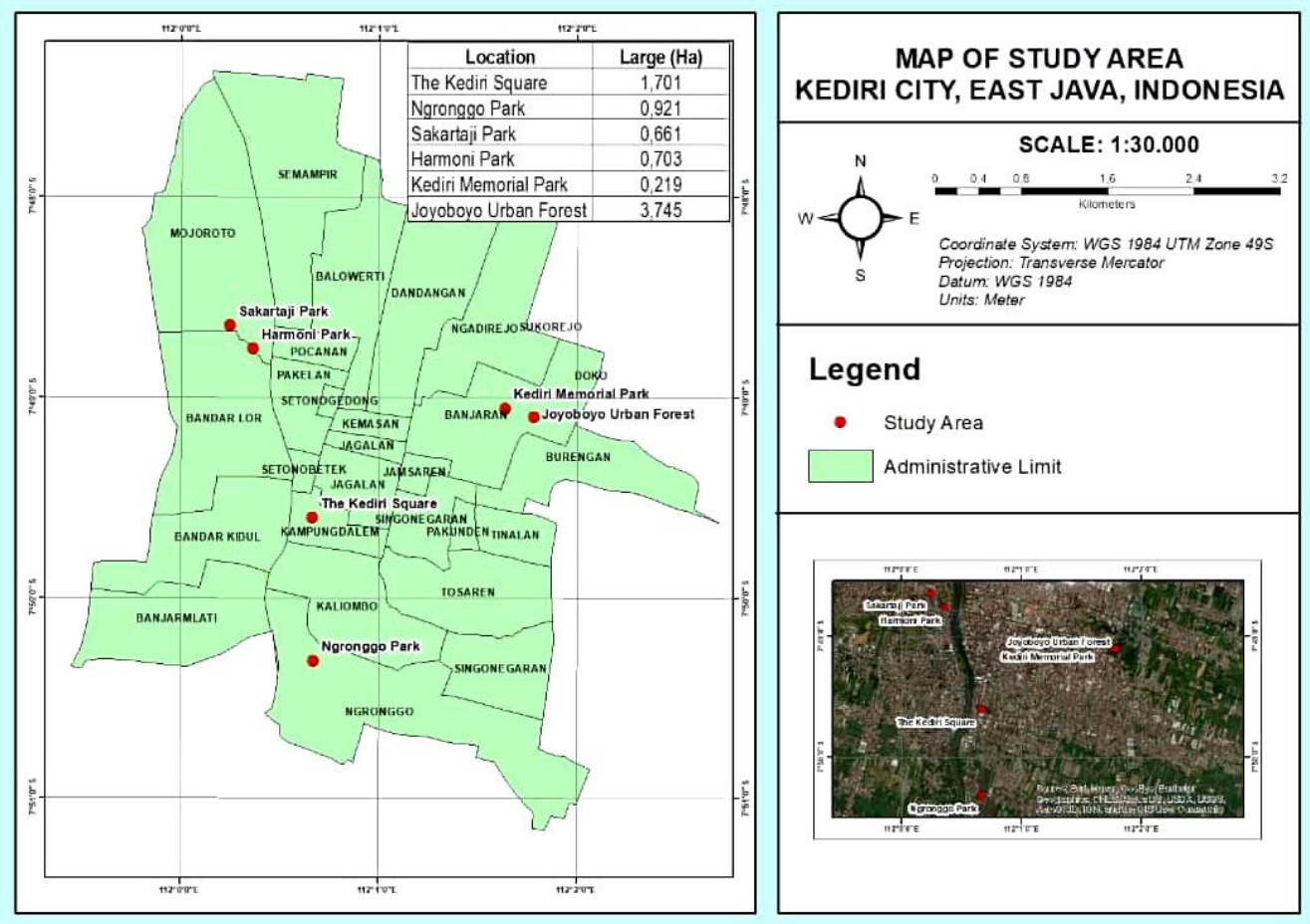

Figure 1. The map of the sites of urban parks and an urban forest of Kediri City, East Java, Indonesia, i.e., The Kediri Square, Ngronggo Park, Sekartaji Park, Harmoni Park, Kediri Memorial Park, and Joyoboyo Urban Forest

Table 1. Suitability assessment indicators, components, criteria, and the score of urban tree species

Indicators	Components	Criteria	Description
Silviculture	Elevation	0-200 m asl > 500 m asl	Most of Kediri's areas are at 63-100 m asl.
	Rainfall	1,000-2,021 mm/year < 1,000 and > 2021 mm/year	Kediri has a rainfall of 1000-2021 mm/year.
	Nutrient-poor soil tolerance	Tolerant Not tolerant	Generally, trees can become more adaptive in soil conditions. Still, urban areas probably have much more significant differences in soil substrates than what can be assumed through a tree plantation program
	Restoration of soil fertility	Possible Not possible	Urban areas probably have much more significant differences in soil substrates. Thus it is important to select urban trees that can restore soil conditions.
	Pests and diseases resistance	Resistant Not resistant	Tree pests and diseases may cause death to trees.
	Shed leaves	Evergreen Deciduous	An evergreen canopy can provide shade and produce oxygen.
	Stem and branch resistance from wind	Not easy to fall and break Easy to fall and break	Death and severe damage may result from falling trees and branches.
	Root condition of the surrounding buildings	Not destroying/disturbing Destroying/disturbing	Roots may damage pavements and cause mishaps to people.
	High-temperature tolerance	Tolerant Not tolerant	Climate change increases temperature gradually, which impacts the phenology of trees.
	Light tolerance	Tolerant Not tolerant	Trees planted around the tall building areas may endure low light levels for part of the day/year.
	Water stress tolerance	Tolerant Not tolerant	Water stress is primarily intervened through working the stomatal gap of the trees (water use effectiveness).
Management	Planting method	Easy Difficult	East to plant trees may reduce budget and efforts.
	Maintaining Method	Easy and cheap Difficult and expensive	Easy-maintaining trees may reduce budget and effort.
	Security Method	Easy Difficult	When trees grow bigger, they can cause potential damage to public safety.
	Utilization method	Easy Difficult	The utilization should be done according to the functions and objectives of urban forest establishment.
	The function of the canopy as a shade (thick and tight)	Good Not good	Thick and tight canopy provide shade.
	The function of the canopy as wind protection (strong and tight)	Good Not good	A strong and tight canopy protects against wind.
	Ability to reduce pollution	High Low	Emissions from vehicles and industry are high in urban areas.
Aesthetic	Habit (canopy, branching, leaf and/or flower)	Beautiful Not Beautiful	Beautiful trees can increase the aesthetic value of the urban environment. However, the judgment is subjective because these attributes allude to aesthetic aspects such as the crown space, color, flowers, odor of the leaves, and fruits.
	Function for education	Yes No	Trees can be used for educational purposes.
	Fruit size	Small Big	Large fruit may potentially cause damage to people at the sites.
	Toxic/dangerous sap	No Yes	Toxic sap may potentially cause damage to people at the sites.
	Potential allergies from pollen	No Yes	Pollen may potentially cause damage to some people that are allergic to pollen at the sites.

Source: Saebo et al. (2005); Indriyanto (2006); Mukhlison (2013); asl (above sea level)

RESULTS AND DISCUSSION

The tree species diversity in urban parks and an urban forest of Kediri City

According to Government Regulation Number 63 of 2002 regarding Urban Forests, the urban parks and urban forests in Kediri were established to conserve germplasm, recreation, and protection, and the shapes were clumped and lined (Figure 2). Twenty-nine tree species belonging to 17 families were recorded in this study (Table 2) (Sulistiyowati and Yuantika 2019). Urban Forest of Joyoboyo had the richest tree species diversity with 15 species. On the other hand, Harmoni Park had only three tree species, the lowest tree species diversity. The tree species diversity is affected by the area of the parks or forest. Urban Forest Joyoboyo has the largest area, i.e., 3.745 Ha. *Beringin* (*F. benjamina*) and *glodokan tiang* (*P. longifolia*) were tree species most frequently found in the six study sites. Fabaceae had the most tree species (five species), followed by Arecaceae (four species). According to Mukhlison (2013), Fabaceae was also prevalent in 10 urban forests of Yogyakarta City. However, species from the family Fabaceae were not found in urban forests in the same province, Trenggalek District (Amianti et al. 2019).

Knowing natural distribution is essential to prevent the potential damage of invasive species in the ecosystem (Vogt et al. 2017). In this study, the number of exotic tree species (17 or 58.62%) was higher than that of the native ones (12 or 41.38%). More exotic species were also found in roadside trees in five cities of Sumatra (Wiryono et al. 2018). The presence of exotic species may result in a negative impact on the native species in urban green spaces, such as the risk for animal-plant interaction, escalate the negative impact of biological invasion, threaten biodiversity preservation, and reduce the reproductive success of indigenous tree species (e Silva et al. 2020). However, according to Sjöman et al. (2018), native tree species might be too restricted to provide ecosystem services and resilience in challenging urban circumstances based on the investigation in Central and Northern Europe. Exotic and native species have advantages and disadvantages. For instance, exotic tree species promote lower arthropod communities than native tree species but may also be more resistant to herbivorous pests (Frank et al. 2019).

One endangered tree species found in the Kediri Square and Joyoboyo Urban Forest was *Angsana* (*P. indicus*). Even though this is classified as an endangered species, it can still be found as an urban tree in Indonesia (Julianty et al. 2015). 11 species (37.93%) were found as the least concern (LC) based on IUCN status. On the other hand, *Mahoni* (*S. mahogany*), located in Kediri Memorial Park, and the Urban Forest of Joyoboyo were classified as near threatened (NT). Moreover, *mangga* (*M. indica*) in the Urban Forest of Joyoboyo was classified as data deficient (DD).

The tree species suitability in urban parks and an urban forest of Kediri City

The result of the suitability assessment showed that 21 urban tree species had a high level of suitability, and only eight urban tree species had a medium level (Table 3). *Cemara angin* (*C. equisetifolia*) and *trembesi* (*A. saman*) had the highest score, i.e., 44. On the other hand, *sirsak* (*A. muricata*) and *blimbing* (*A. carambola*) had the lowest score, namely 36. Therefore, most medium-level tree species were found in the Urban Forest of Joyoboyo.

Figure 1. The study sites of urban parks and an urban forest of Kediri City, East Java, Indonesia: 1. The Kediri Square, 2. Ngronggo Park, 3. Sekartaji Park, 4. Harmoni Park, 5. Kediri Memorial Park, and 6. Joyoboyo Urban Forest

Table 2. Status of the tree species in Urban Parks and an Urban Forest in Kediri City, East Java, Indonesia

Local name	Scientific name	Family	Exotic or native	IUCN
Akasia	*Acacia mangium* Willd.	Fabaceae	E	LC
Angsana	*Pterocarpus indicus* Willd.	Fabaceae	N	EN
Aren	*Arenga pinnata* (Wurmb) Merr.	Arecaceae	N	NA
Beringin	*Ficus benjamina* L.	Moraceae	N	LC
Bintaro	*Cerbera manghas* L.	Apocynaceae	N	LC
Blimbing	*Averrhoa carambola* L.	Oxalidaceae	N	NA
Bunga kupu-kupu	*Bauhinia purpurea* L.	Fabaceae	E	NA
Cemara angin	*Casuarina equisetifolia* L.	Casuarinaceae	N	LC
Flamboyan	*Delonix regia* (Hook.) Raf.	Fabaceae	E	LC
Glodokan tiang	*Polyalthia longifolia* (Sonn.) Thwaites	Annonaceae	E	NA
Jambu air	*Syzygium aqueum* (Burm.f.) Alston	Myrtaceae	N	LC
Kamboja merah	*Plumeria rubra* L.	Apocynaceae	E	NA
Karet kebo	*Ficus elastica* Roxb. ex Hornem.	Moraceae	N	NA
Kayu putih	*Melaleuca leucadendra* (L.) L.	Myrtaceae	E	NA
Kepuh	*Sterculia foetida* L.	Sterculiaceae	N	NA
Ketapang kencana	*Terminalia mantaly* H.Perrier	Combretaceae	E	LC
Kiara payung	*Filicium decipiens* (Wight & Arn.) Thwaites	Sapindaceae	E	NA
Mahoni	*Swietenia mahagoni* (L.) Jacq.	Meliaceae	E	NT
Mangga	*Mangifera indica* L.	Anacardiaceae	E	DD
Mindi	*Melia azedarach* L.	Meliaceae	E	LC
Nyamplung	*Calophyllum inophyllum* L.	Clusiaceae	N	LC
Palem kuning	*Dypsis lutescens* (H.Wendl.) Beentje & J.Dransf.	Arecaceae	E	NT
Palem merah	*Cyrtostachys renda* Blume	Arecaceae	N	NA
Palem raja	*Roystonea regia* (Kunth) O.F.Cook	Arecaceae	E	NA
Sawo manila	*Manilkara zapota* (L.) P.Royen	Sapotaceae	E	NA
Sirsak	*Annona muricata* L.	Annonaceae	E	LC
Talok	*Muntingia calabura* L.	Muntingiaceae	E	NA
Trembesi	*Albizia saman* (Jacq.) Merr.	Fabaceae	E	NA
Waru	*Hibiscus tiliaceus* L.	Malvaceae	N	LC

Note: E (Exotic) and native (N); Extinct (EX), extinct in the wild (EW), critically endangered (CR), endangered (EN), vulnerable (VU), near threatened (NT), least concern (LC), data deficient (DD), not evaluated (NE), no available (NA). Source: CABI (2021); Sulistiyowati and Yuantika (2019), IUCN (2021).

Table 3. The tree species suitability assessment in urban parks and an urban forest in Kediri City, East Java, Indonesia

Scientific name	Family	Location						Score	Level
		1	2	3	4	5	6		
Acacia mangium	Fabaceae	-	-	+	-	-	-	38	M
Pterocarpus indicus	Fabaceae	+	-	-	-	-	+	40	H
Arenga pinnata	Arecaceae	+	+	-	-	-	-	42	H
Ficus benjamina	Moraceae	+	-	+	+	+	+	41	H
Cerbera manghas	Apocynaceae	-	+	+	-	-	-	40	H
Averrhoa carambola	Oxalidaceae	-	-	-	-	-	+	36	M
Bauhinia purpurea	Fabaceae	+	+	+	-	-	+	37	M
Casuarina equisetifolia	Casuarinaceae	+	+	-	-	-	-	44	H
Delonix regia	Fabaceae	+	+	+	-	-	+	38	M
Polyalthia longifolia	Annonaceae	+	+	+	+	+	-	42	H
Syzygium aqueum	Myrtaceae	-	-	-	-	-	+	42	H
Plumeria rubra	Apocynaceae	-	+	-	-	-	-	39	H
Ficus elastica	Moraceae	-	+	-	-	-	-	41	H
Melaleuca leucadendra	Myrtaceae	-	-	+	-	-	-	42	H
Sterculia foetida	Sterculiaceae	-	-	-	-	-	+	40	H
Terminalia mantaly	Combretaceae	+	+	+	-	+	-	37	M
Filicium decipiens	Sapindaceae	-	-	+	-	-	-	41	H
Swietenia mahagoni	Meliaceae	-	-	-	-	+	+	44	H
Mangifera indica	Anacardiaceae	-	-	-	-	-	+	37	M
Melia azedarach	Meliaceae	-	-	+	-	-	-	41	H
Calophyllum inophyllum	Clusiaceae	-	-	-	-	-	+	40	H
Dypsis lutescens	Arecaceae	-	-	-	+	-	-	40	H
Cyrtostachys renda	Arecaceae	-	+	-	-	-	-	40	H
Roystonea elata	Arecaceae	+	+	-	-	+	+	39	H
Manilkara zapota	Sapotaceae	+	+	-	-	+	-	42	H
Annona muricata	Annonaceae	-	-	-	-	-	+	37	M
Muntingia calabura	Muntingiaceae	+	-	-	-	-	+	42	H
Albizia saman	Fabaceae	-	-	+	-	-	+	41	H
Hibiscus tiliaceus	Malvaceae	-	-	-	-	-	+	38	M

Note: 1. The Kediri Square, 2. Ngronggo Park, 3. Sekartaji Park, 4. Harmoni Park, 5. Kediri Memorial Park, and 6. Joyoboyo Urban Forest; High (H), medium (M), and low (L); presence (+) and absent (-). Source: CABI (2021); Sulistiyowati and Yuantika (2019)

Silviculture indicators

The urban tree species must meet the silvicultural requirements, i.e., edaphic, climatic, physiographic, and biological (Indriyanto 2006). Based on ecological conditions, the number of tree species in the study sites suitable for elevation and rainfall was 29 (Table 4). They are suitable for the altitude (63-100 asl) and annual precipitation (1,000-2,021 mm per year with the number of rainy days of 80–130 per year) of Kediri City. Many of the tree species are also tolerant to high temperatures (19 species), solar radiation (24 species), drought stress (26 species), and resistance to pests and diseases (19 species).

Regarding the edaphic conditions, 28 tree species can also grow in nutrient-poor soil. Only *jambu air* (*Syzygium aqueum*) needs fertile planting media that contains many organic materials, aeration, and drainage in loose and good soil (Sagala et al. 2017). Six species can restore soil, namely *trembesi* (*A. saman*), *flamboyan* (*D. regia*), *akasia* (*A. mangium*), *cemara angin* (*C. equisetifolia*), *mangga* (*M. indica*), and *angsana* (*P. indicus*) because they can adjust atmospheric nitrogen (Karthikeyan et al. 2013; Combalicer et al. 2014; Kumar 2016: Narendra and Pratiwi 2016).

All the tree species found in the study sites are classified as evergreen trees, 26 of which have strong stems and branches. The root of the three tree species may cause damage to the surrounding buildings (pavement and road), namely *trembesi* (*A. saman*), *beringin* (*F. benjamina*), and *angsana* (*P. indicus*). According to Syahbudin et al. (2018a), *angsana* (*P. indicus*) starts to cause damage when it has a diameter from 30 to 39 cm (the sidewalk) and 20 to 29 cm (the divider). Therefore, the tree species with potential root problems must not be planted because they can be dangerous and raise public complaints (Hasan et al. 2017a; Hasan et al. 2017b).

Management indicators

Management indicators are considered for the planting method selected for the maintenance and security of urban tree species (Indriyanto 2006). Meanwhile, according to Saebo et al. (2015), the tree species selected for GOS must function as a shade (thick and dense leaves), a windbreaker (strong and tight crowns), and can reduce environmental pollution (air, soil, and water). Furthermore, in management, comprehensive aspects must be considered regarding the caring of young plants, tree removal options, and replacement of removed trees (Vogt et al. 2017). Furthermore, trees growing under unsupportive habitat conditions can still create a better and healthier environment with suitable maintenance activities, including irrigation, fertilization, management of pests and diseases, etc.

Therefore, it is necessary to plant diverse tree species to make urban trees resistant to pests and diseases and resilient to climate variability. The diversity of urban trees is important because climate change will bring several negative impacts, such as reducing rainfall, increasing temperature, CO_2, particulate matter pollutants, photochemical pressure, and extremely hot days (Bussotti et al. 2014). Thus, choosing suitable trees is crucial for the management aspect. Moreover, to prevent death and severe injury from falling trees and branches, as well as root damage, four actions should be taken: (i) regularly assessing the health and structure of trees, location, and weather, (ii) cutting root and branch, (iii) applying alternate planting between the young and the old trees, and (iv) using platform mobile-based, artificial intelligence, and internet of things (IoT) to report social and environmental problems in the smart city (Brookes 2007; Syahbudin et al. 2018).

Table 4. The characteristics of tree species based on the silvicultural indicators

Scientific name	Elevation	Rainfall	Nutrient-poor soil tolerance	Restoration of soil fertility	Pests and diseases resistance	Shedding leaves	Stem and branch resistance to wind	Root condition of the surrounding buildings	High-temperature tolerance	Light tolerance	Drought stress tolerance
Acacia mangium	+	+	+	+	–	+	+	+	+	+	+
Pterocarpus indicus	+	+	+	+	+	+	+	–	–	+	+
Arenga pinnata	+	+	+	–	+	+	+	+	+	+	–
Ficus benjamina	+	+	+	–	–	+	+	–	+	+	+
Cerbera manghas	+	+	+	–	+	+	+	+	+	+	+
Averrhoa carambola	+	+	+	–	–	+	+	+	+	+	+
Bauhinia purpurea	+	+	+	–	+	+	+	+	+	+	+
Casuarina equisetifolia	+	+	+	+	+	+	+	+	+	+	+
Delonix regia	+	+	+	+	–	+	+	+	+	+	+
Polyalthia longifolia	+	+	+	–	+	+	+	+	–	+	+
Syzygium aqueum	+	+	–	–	–	+	+	+	–	–	–
Plumeria rubra	+	+	+	–	–	+	+	+	+	+	+
Ficus elastic	+	+	+	–	+	+	–	–	+	+	+
Melaleuca leucadendra	+	+	+	–	+	+	+	+	+	+	+
Sterculia foetida	+	+	+	–	+	+	+	+	–	–	–
Terminalia mantaly	+	+	+	–	+	+	+	+	–	–	+
Filicium decipiens	+	+	+	–	+	+	+	+	–	–	+
Swietenia mahagoni	+	+	+	–	+	+	+	+	+	+	+
Mangifera indica	+	+	+	+	–	+	+	+	+	+	+
Melia azedarach	+	+	+	–	+	+	+	+	+	+	+
Calophyllum inophyllum	+	+	+	–	+	+	+	+	+	+	+
Dypsis lutescens	+	+	+	–	+	+	+	+	–	+	+
Cyrtostachys renda	+	+	+	–	+	+	+	+	–	+	+
Roystonea regia	+	+	+	–	+	+	+	+	–	+	+
Manilkara zapota	+	+	+	–	–	+	+	+	+	+	+
Annona muricata	+	+	+	–	–	+	+	+	–	–	–
Muntingia calabura	+	+	+	–	+	+	+	+	+	+	+
Albizia saman	+	+	+	+	+	+	–	–	+	+	+
Hibiscus tiliaceus	+	+	+	–	–	+	–	+	+	+	–

Note: Suitable (+) and unsuitable (–). Source: CABI (2021)

Table 5. The functions of tree species and architecture models in urban parks and an urban forest in Kediri City

Scientific name	The function of the canopy		Architecture model	References
	Shade	Windbreaker		
Acacia mangium	+	+	Troll	Orwa et al. (2009)
Pterocarpus indicus	+	+	Troll	Orwa et al. (2009)
Arenga pinnata	–	–	Corner	CABI (2021)
Ficus benjamina	+	+	Troll	CABI (2021)
Cerbera manghas	–	–	Koriba	CABI (2021)
Averrhoa carambola	+	–	Troll	CABI (2021)
Bauhinia purpurea	+	+	Troll	CABI (2021)
Casuarina equisetifolia	+	+	Rauh	CABI (2021)
Delonix regia	+	–	Troll	CABI (2021)
Polyalthia longifolia	–	+	Raux	CABI (2021)
Syzygium aqueum	+	+	Troll	Sirisha and Shreeja (2019)
Plumeria rubra	–	–	Leeuwenberg	CABI (2021)
Ficus elastica	+	–	Troll	CABI (2021)
Melaleuca leucadendra	–	–	Rauh	CABI (2021)
Sterculia foetida	+	–	Aubreville	CABI (2021)
Terminalia mantaly	+	–	Aubreville	CABI (2021)
Filicium decipiens	–	–	Troll	CABI (2021)
Swietenia mahagoni	+	+	Rauh	Orwa et al. (2009)
Mangifera indica	+	–	Scarrone	CABI (2021)
Melia azedarach	+	+	Troll	CABI (2021)
Calophyllum inophyllum	+	+	Leeuwenberg	CABI (2021)
Dypsis lutescens	–	–	Corner	CABI (2021)
Cyrtostachys renda	–	–	Corner	CABI (2021)
Roystonea regia	–	–	Corner	CABI (2021)
Manilkara zapota	+	+	Troll	Orwa et al. (2009)
Annona muricata	+	+	Troll	CABI (2021)
Muntingia calabura	+	+	Troll	Ken Fern (2014)
Albizia saman	+	–	Troll	CABI (2021)
Hibiscus tiliaceus	+	–	Scarrone	CABI (2021)

Note: Suitable (+) and unsuitable (–)

Some of the tree species in the study sites can be used as a windbreaker (13 species) and a canopy shade (20 species). In addition, most architectural models of trees are a troll (14 species). On the other hand, through the urban food forest concept, which is a multidisciplinary approach between urban forestry, edible landscaping, urban agriculture, and agroforestry, woody food-producing species can also contribute to food security and natural medicine sources in a city (McLain et al. 2012; Clark and Nicholas 2013; Poe et al. 2013). Furthermore, a sustainable urban forest can restore the city and bring it closer to nature (Afrianto and Tamnge 2015).

Trees selection based on the potential for reducing air pollution in cities must be considered as one of the critical aspects. Urban tree species that can absorb (i) carbon monoxide (CO) were *kiara payung* (*F. decipiens*), and *bunga kupu-kupu* (*B. purpurea*) (Kusminingrum 2008), (ii) heavy metal lead (Pb) were *mahoni* (*S. mahagoni*), *angsana* (*P. indicus*), *manga* (*M. indica*), *bunga kupu-kupu* (*B. purpurea*), *glodokan tiang* (*P. longifolia*), *bunga kupu-kupu* (*B. purpurea*), and *akasia* (*A. mangium*) (Dahlan et al. 1989; Siringoringo 2000; Yudha et al. 2013; Fahruddin 2020), and (iii) nitrogen dioxide (NO2) were *angsana* (*P. indicus*) and *flamboyan* (*D. regia*) (Sulistijorini 2009).

Aesthetic indicators

Aesthetic indicators are divided into five criteria supporting urban parks and forests (Saebo et al. 2005; Indriyanto 2006). Firstly, the urban tree species selected should have a beautiful canopy, branching, leaves, and flowers to function as an aesthetic enhancer or the beauty of an urban environment. In this present study, several ornamental plant species were found, such as *trembesi* (*A. saman*), *flamboyan* (*D. regia*), *kamboja merah* (*P. rubra*), *palem kuning* (*D. lutescens*), *palem merah* (*C. renda*), and *palem raja* (*R. regia*).

Secondly, the urban tree species selected should have the function of education, health improvement, and social culture. Several mental health issues, such as anxiety, stress, depression, and post-traumatic stress disorder, can be reduced by watching aesthetic plants (Husti et al. 2015; Hassan et al. 2018; Hall and Knuth 2019). In Javanese culture, *beringin* (*F. benjamina*) with troll architecture model has a philosophical value as the protection symbol (Syahbudin et al. 2018b). Besides serving aesthetic purposes, planting native and endangered species in GOS, such as *angsana* (*P. indicus*), can conserve those species and educate the community.

Thirdly, the urban tree species selected should have relatively small fruit so that it does not endanger humans or

damage surrounding facilities/buildings when it falls. In this study, the tree species with no large fruit may potentially cause damage to people at the sites.

Fourthly, those urban tree species must not produce sap toxic or harmful to living things. Several tree species in the study sites have been reported as poisonous species. For example, *Mindi* (*M. azedarach*) is a traditional Chinese medicine for antifungal and antiphrastic agents. But, this species has been reported to contain poison for humans that were indicated to causing in respiratory, gastrointestinal, neurological effects, cardiovascular, and death in severe cases (Phua et al. 2008). In the Eastern Province of Sri Lanka, seeds of *bintaro* (*C. manghas*) are commonly used for self-poisoning (Selladurai et al. 2016). Through IQ Ultra chambers, the stem and leaf of *mangga* (*M. indica*) and *waru* (*H. tiliaceus*) demonstrated allergic contact dermatitis (Watts et al. 2017).

Lastly, those urban tree species must not produce pollen that is potentially allergenic to humans. Persons with latex allergy and atopic are suggested to avoid *beringin* (*F. benjamina*) (Axelsson 1995; Schenkelberger et al. 1998; Werfel et al. 2001). Queensland Government and the United States Department of Agriculture (USDA) classified *kamboja merah* (*P. rubra*) as a poisonous plant ("USDA" n.d.; "Queensland Government" n.d.). *Blimbing* (*A. carambola*) has clinical evidence containing high levels of oxalic acid that may cause renal failure in humans (Neto et al., 2003). Pollen allergens have been rising in the last decades because of climate change impact (Damialis et al. 2019). Pollen allergens showed a high-risk factor for asthma and seasonal allergic rhinitis (Chen et al. 2016). In this study, for instance, *cemara angin* (*C. equisetifolia*) and *flamboyan* (*R. regia*) had been reported as aeroallergen (Bucholtz et al. 1987; Raj and Prakshumar 2018). In addition, to prevent that, education boards must describe the poisoning that may result from these species and the risk of allergen pollen to visitors.

In conclusion, from this study, it can be concluded that the diversity of urban tree species (29 urban tree species from 17 families) is essential for urban parks and an urban forest in Kediri City, such as the conservation of germplasm, recreation, and protection. Moreover, the suitability levels of urban tree species in urban parks and an urban forest of Kediri City were medium to high (36-44). Therefore, planting suitable urban tree species will effectively mitigate the impacts of environmental problems such as climate change, pests and diseases, and management problems.

ACKNOWLEDGEMENTS

We thank Dini Ayu Lestari for her help in creating the study site map. All authors contributed equally to the experiment and the writing of this paper. Furthermore, all authors declared no conflict of interest.

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