Urban trees in the Cities of Matsuyama (Japan) and Yogyakarta (Indonesia): tree species diversity, design, and culture

A Syahbudin¹, D T Adiyanti¹, B Mulyana¹, A Meinata¹, S P Phenomenon¹, A S H Hanindita², R L Syaufina², R Yudhistira², R Arifiana³, Makkarennu⁴, K Osozawa⁵ and I Ninomiya⁵

¹ Faculty of Forestry, Universitas Gadjah Mada, Jl. Agro 1A Bulaksumur UGM, Yogyakarta 55281, Indonesia
²Graduate Student of Faculty of Forestry, Universitas Gadjah Mada, Jl. Agro 1A Bulaksumur UGM Yogyakarta 55281, Indonesia
³Vocational School, Universitas Gadjah Mada, Sekip Unit 1, Catur Tunggal, Sleman, Yogyakarta 55281, Indonesia
⁴Faculty of Forestry Universitas Hasanuddin, Jl. Kandea III No.5, Makassar City, Sulawesi Selatan 90153, Indonesia
⁵Faculty of Agriculture Ehime University, Matsuyama City, Ehime 7908566, Japan

E-mail: syahbudinatus@gadjahmada.edu

Abstract. The objective of this study was to assess the diversity and value of the tree species within the urban design of Yogyakarta and Matsuyama. We acquired the data by exploring the urban areas of Matsuyama, mainly main roads, during 2010-2013, while in Yogyakarta between 2015 and 2017. We identified the species of the trees and obtained the cultural value of them by interview. Matsuyama’s urban forest has a distinctive vegetation on sakura (Prunus spp.), Japanese pine (Pinus sp.) and camellia (Camellia sp.). It develops urban designs for protecting and maintaining the urban forest i.e. a protective railing, a ring around the base of the stem, and a carpet for moisturizing and protecting. The Japanese pine is depicted as a city emblem, while camellia is visualized on the culvert cover. In Yogyakarta’s urban forest, Pterocarpus indicus dominates as a shade tree with Mimusops elengi, Samanea saman, Tamarindus indica, Ficus elastica, and/or Canarium indicum. Mentaok (Wrightia javanica) as a historical tree has great potential. The urban trees grow in the pots in the median and roadside. Malioboro Street has already built protective fences and rings around the base of the stem. Yogyakarta has also a philosophical axis that symbolized human journey. The axis keeps 8 tree species based on palace guidance.

1. Introduction
Human makes cities as the center of its activities [1]. As a result, the city has a high population density [2], which also brings up the next issues such as the availability of land and land management [3].
However, cities need sustainable development that takes into ecological, social, economic, building, and human well-being [4,5,6]. In daily life, human needs biodiversity to meet their needs, like food and other necessities. Biodiversity also requires space in the city, such as the corridor and patch areas that have a significant effect on urban forest biodiversity [7]. Vegetation in the city, mainly trees diversity, are also very important for keeping the genetic basis in nature [8], supporting urban ecology [6,9] and social ecosystem [10,11]. Syahbudin et al [12,13] confirmed that the new stand of *Casuarina equisetifolia* in Yogyakarta causes local people able to create new social values, improve environmental quality and increase people's incomes. The existence of vegetation also helps civet produce expensive coffee beans [14].

On the other hand, conflicts of land use in the city may occur due to differences in interests [15]. Therefore, we need to learn from developed countries on how to build urban areas, to linkages rural-urban [16], and to understand the dynamics of urban systems [4]. In order to support of urban forest development in Yogyakarta as a city in developing countries, Indonesia, we conducted a benchmarking study with the city of Matsuyama in Japan in terms of conserving cultural and indigenous trees in the city and promoting ecotourism. In line with those activities, this study was carried out to assess the tree diversity, urban tree design, and cultural values on tree species between urban forests of Yogyakarta and Matsuyama.

### 2. Method

The urban areas of Matsuyama was explored between 2010 and 2013 in order to conduct an inventory and identify the vegetations, mainly trees in some main roads, and to record where and how the vegetations have been established. The data of urban trees in Yogyakarta were also collected by exploring, but it was done between 2015 and 2017 (figure 1). In addition, for historical tree species in Yogyakarta like the mentaok tree (*Wrightia javanica* A.DC.; Apocynaceae), the mentaok stature was obtained by tracing it from ancient sources such as Atlas der Baumarten von Java Vol. 4 drawn by Mangoendimedjo [17]. We also visited the tomb of Kotagede, Yogyakarta in order to identify the morphology of the species. The cultural value obtained by interview and equipped with secondary data through literature study (figure 2). The interviews were done with the spokesperson of the Yogyakarta Sultanate (figure 3), and the Environment Agency of Yogyakarta.

### 3. Result and discussion

#### 3.1. Tree species diversity

The characteristics of Matsuyama’s urban forest is the existence of cherries or *sakura* (*Prunus* spp.), Japanese pine (*Pinus* sp.) and camellia (*Camellia* sp.). We found *P. lannesiana*, *P. mume*, and *P. jamasakura* for *Prunus* spp. Susan et al [18] explained that cherry blossom festival greatly affects the
local economy. Changes in the flowering period due to global warming would be a serious concern to festival managers. In addition, this study also recorded other species as presented in figure 4, namely: Ginkgo biloba, Acer palmatum, A. buergerianum, Ilex rotunda, Styrax japonica, Podocarpus macrophyllus, Magnolia praeocissima, Cornus florida, and Metasequoia glyptostroboides. Flowering plants which were also met are Rhododendron sp. and Campsis chinensis, as well as shrubs abelia x grandiflora.

Figure 4. Tree species in Matsuyama urban forest: (a) Prunus sp., (b) Camellia sp., (c) Pinus sp., (d-e) Ginkgo biloba, (f-h) Ilex rotunda, (i-j) Acer sp., (k) Styrax japonica, (l-m) Magnolia praeocissima, (n) Cornus florida, (o) abelia x grandiflora (shrubs), (p) Rhododendron sp. (herb).
Matsuyama resident in the urban area also cultivates *Lantana camara* (Verbenaceae), which is often found under the stand of the teak (*Tectona grandis*) plantation in Java’s deciduous forest of Indonesia. They make this species as an ornamental plant around the house. Several studies have reported that *L. camara* has become invasive species. It was imported to Japan since ca. 1865. and also cultivated worldwide, but native to the American tropics and conforming has a broad ecological tolerance. Matsuyama resident seems like its wide selection of colors (figure 5). This flowering plant is placed in front of the house on several conditions, both in the pot and directly on the ground (figure 6).

![Figure 5. Flowers of *Lantana camara* (Verbenaceae) in Matsuyama urban forest.](image)

![Figure 6. *Lantana camara* (Verbenaceae) as an ornamental plant in Matsuyama: (1a-1e) *L. camara* in the courtyard terrace or garden of Matsuyama city resident and apartment, (2a-2c) *L. camara* in the roadside, (3a-3b) *L. camara* in the university garden.](image)
Based on figure 4–figure 6, it appears that the development of vegetation in Matsuyama has been followed by culture for planting and loving flowers. We also found florist or horticulturist who developed the flower species for commercial production.

Compared to Yogyakarta city, the main roads of the urban forest has more trees species than Matsuyama city. The philosophical axis of Yogyakarta has 359 trees within 24 species [19]. In general, angsana (*Pterocarpus indicus*) dominates the urban tree in Yogyakarta as a shade tree. The other species of shade trees are *Minusops elengi*, *Samanea saman*, *Tamarindus indica*, *Canarium indicum*, and *Ficus elasticus*. Mukhlison [20] reported that 112 tree species in the urban forest of Yogyakarta are divided into three groups of species i.e. conservation, recreation, and protection.

As a cultural and educational city, Yogyakarta has originated from the *alas mentaok* (*mentaok forest*) trying to make the road atmosphere with memorable trees of *mentaok* (*Wrightia javanica* A.DC.). *Mentaok* is a historical and indigenous tree species of Yogyakarta. In ancient times, the governance of the Islamic Sultanate of Mataram came from the opening of a dense tropical forest named *alas mentaok* by Ki Ageng Pemanahan and Ki Juru Martani into a village (figure 7). At this time, the former *alas mentaok* is estimated in Kotagede district, Yogyakarta. Restoring *mentaok* as one of the main tree species in the urban forest of Yogyakarta is considered as a necessity. However, it is predicted that only a very small number of mature trees remain. We documented one *mentaok* trees in the tomb of Kotagede (figure 8).

![Figure 7](image-source.png)

**Figure 7.** *Mentaok* (*Wrightia javanica*) as a historical and indigenous tree species of Yogyakarta: (a) Tree of *mentaok* (image source [17], (b) Diorama of *alas mentaok* (*mentaok forest*) deforestation at the city hall of Yogyakarta.
Mentaok which previously has existed on the alas mentaok is a tree species in the Apocynaceae Family and the Wrightia Genus. According to figure 7 and 8, mentaok is estimated to have a height of up to 30 meters. Bark is light brown to dark. The trunk is alleged to have a fairly deep crack according to the image of the diorama at the City Hall of Yogyakarta. The wood is solid and white. Single leaf and opposite. The leaf is good enough for shading. Bisexual flowers, yellowish-white, in the form of panicles at the tip of the twig. Fruit is oval shaped with a hard fruit skin and has a hemisphere in the middle. The color of the fruit is brownish, will break when they are old and the seeds will spread. Fruits may cause a litter problem, but not to harm the pedestrians. The Mentaok tree can be grafted, exploited by other ornamental plants to attach as: W. religiosa and Jasminum sp. The wood can be used for placing the kris (warangka keris).

3.2. Trees in urban design
Matsuyama develops some urban designs for protecting and maintaining the urban forest i.e. a protective railing, a circular or square-shaped iron ring, and a carpet (figure 9).
Figure 9. Several designs in Matsuyama’s urban forest: (a) wooden fences to hold, (b) a mast or protective railing of approximately 1 m, either from wood or iron, (c-e) a circular or square-shaped iron ring around the base of the stem, (f) carpet for moisturizing and protecting the weed.

In the urban forest of Yogyakarta, the trees are generally grown using pots in the median road, roadside or curb (figure 10a- figure 10b). Provision of protective fences and circular iron ring around the base of the stem can be found in Malioboro Street (figure 10c- figure 10g).

Currently, tree planting using pots in the median road, roadside or sidewalk still faces several obstacles, such as in many angsana trees. Roots of the angsana that grow near the surface of the road are able to lift the asphalt, crack pavement and pot walls. Therefore, actually angsana is not recommended to be established in the sidewalk and around public facilities [21].
Figure 10. Urban designed-trees in Yogyakarta: (a-b) trees grow using pots in the median road or roadside, (c-g) Since 2017, Malioboro Street starts to use protective fences and circular iron ring around the base of the stem of the tree.

3.3. Trees philosophy

Related to the cultural value of tree species, Matsuyama has an official flower, namely: Camellia sp. that has been established in temples and all over Matsuyama. Camellia is visualized on the culvert cover. Matsuyama city also has the Japanese pine (Matsu) that is depicted in a city emblem of Matsuyama (figure 11).

The city of Yogyakarta has a philosophical axis from Panggung Krapyak to Tugu since 1755. The tree species along the philosophical axis that symbolizes human journeys were mentioned in Serat Salokapatra [22]. Syahbudin et al. [19] The recorded 8 species in the philosophical axis among the 24 species based on the palace guidance (pakem keraton). Those are Tamarindus indica, Ficus benjamina, Inocarpus edulis, Michelia alba, Manilkara kauki, Minusops elengi, Mangifera indica, and M. foetida.

Figure 11. Cultural trees species in Matsuyama city: (a-c) Camellia sp.: flower and trees, (d) the culvert cover of Camellia sp., (e) city emblem of Matsuyama: Japanese pine (Matsu).
4. Conclusion
The main roads of the urban forest of Yogyakarta has more species of trees than Matsuyama. However, Matsuyama has developed more advances and has more detail of urban design for trees. Both cities have culturally valuable trees.

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