*Plant Archives* Vol. 19 No. 1, 2019 pp. 1515-1520 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

# THE SACRED PLANTS AND THEIR SUPPORT FOR CONSERVATION, PONCOKUSUMO DISTRICT, MALANG REGENCY, EAST JAVA INDONESIA

**Dian Siswanto* and Jati Batoro**

Faculty of Mathematics and Natural Sciences, Brawijaya University, Malang -65145, Indonesia

## Abstract

Indonesia had the indigenous cultures, including the traditional belief of local people to the sacred plants. It prevented the big trees for being cut since the people believed that the plant was a dwelling place for ancestral spirits. The conservation of the large plants in several areas provided a lot of benefits to human well-being, however, the information due to the role of plants in the environmental service for air quality was not available. This study included a taxonomical study of sacred plants, their locations and arrangements, and microclimates. A survey and interview were conducted to obtain sacred plant locations and each plant's local names. Further, the sacred plant locations were confirmed by a Geographical Positioning System (GPS). The identification of sacred plants was conducted based on the Flora of Java book. A multi-parameter analyzer was utilized to measure $CO_2$ concentration, temperature, and relative air humidity (plant microclimates). The results showed the genus of sacred plants were *Ficus* and *Casuarina* which were grown at the altitude ranges of 746- 2, 151 meter above sea level (masl). Under sacred plant canopy, the ranges of $CO_2$ concentrations, temperatures, and relative humidity were 306-362 parts per million (ppm), 21.5-31.5°C, and 39.3-75.0%, respectively. However, outside the sacred plant canopy, the ranges of $CO_2$concentrations, temperatures, and relative humidity were 295-362 ppm, 24.6-32.4°C, and 46.8-75.1%, respectively. Both, the conditions under and outside canopy was similar to normal indoor conditions. Moreover, the existence of birds which indicated their potential habitation were also reported.

***Key words:*** Carbon dioxide; temperature; relative humidity; sacred area

## Introduction

In the past several years, the increasing of the human population has led to a decrease in the botanical diversity and environmental quality. This phenomena also happens in Tengger highland located in the eastern part of Java Island, Indonesia. The development of human settlements as well as tourism in this highland usually related to solid waste accumulation, water, and air pollution, vandalism, and illegal flora harvesting (Hakim, 2011). The agricultural modernization also threats the biodiversity conservation (Hakim 2011, Batoro, 2017). Fortunately, Indonesia has a high diversity not only in biology but also in culture (Rhee *et al.*, 2004; Purnomo *et al.*, 2018). The traditional knowledge as a part of indigenous culture, including the traditional belief of local people, has been proved to prevent the decrease of environmental quality (Anthwal *et al.*, 2010).

The Tengger highland is a part of Bromo Tengger Semeru area. This area is a series of mountains, passive and active volcanoes covering the mountain complex of Tengger and Jambangan located at an altitude of 750-3,676 meters above sea level (masl) (Batoro, 2017). Plant diversity in this area consists of forest stands with tall trees, epiphytes, liana, herbs, and shrubs (Pramita *et al.*, 2013; Batoro 2017). In addition to a tropical mountain forest landscape, the topography of this region also consists of a row of Tengger settlements. The Tengger community partially occupies a buffer zone. Their settlement is adjacent to a conservation area that is a combination of production forest and protected forest. Over time, the people of Tengger who used to depend on forest products changed the fulfillment of their life needs on the agricultural sector. The development of agricultural cultivation techniques also affect the selection of crops,

***Author for correspondence :** E-mail : diansiswanto@ub.ac.id

therefore there is a shift in the diversity of tall trees into agricultural cultivation plants including potatoes, leek, cabbage, corn, carrots and apples (Batoro, 2017; Tasbakan *et al.*, 2017). In addition, the increase of tourism activities regarding the visit of Bromo Mountain caldera may disturb the wildlife habitats (Hakim, 2011) However, the traditional belief in sacred plants prevents several areas to be transitioned to agricultural areas or disturbed by tourism activities.

The sacred plants were conserved due to the needs of the Tengger Tribe to utilize the plants for traditional ceremony related to their belief and culture. The Tengger people beliefs that a sacred plant is a dwelling place for ancestral spirits (Purnomo *et al.*, 2018; Mirzamasoumzadeh & Mollasadeghi, 2013). The sacred plants have the specific characteristics such as large, tall, and old. Due to the importance of the sacred plants, Tengger people take care of the plants, together (Batoro, 2017; Purnomo *et al.*, 2018).

The conservation of the large plants in several areas provides a lot of benefits to human well-being. The plants have several functions such as prevents soil erosion, landslide and conserves the spring and water. However, information due to the role of plants in the microclimate for outdoor comfort is not available. This study presented the taxonomical study of sacred plants, their locations and arrangements, and $CO_2$ concentration, air temperature, and relative humidity around the sacred plants. In addition, data of the existence of birds near the area were provided. The information highlighted the role of sacred plants in conservation of environmental services related to the air quality.

## Materials and Methods

### Location observation

Locations of the sacred plants and their administrative status were obtained from interviewing the local people. Furthermore, seven sacred areas were surveyed (Table 1). The place coordinates and altitudes were measured by Geographical Positioning System (GPS) Garmin (Table 2). Further, the arrangements of sacred plants were simplified and presented (Fig. 1).

**Perhutani :** State-owned enterprise in Indonesia which has the duty and authority to organize the planning, management, concession and forest protection in its working area.

### Sacred plant observation and identification

Local names of sacred plants were obtained by an open-ended interview with Tengger people. The specific characteristic of plants based on traditional knowledge was morphologically confirmed to determine the plant scientific names (Table 2). The identification and nomenclature of the listed plants were based on the Flora of Java (Backer and van den Brink, 1968).

### Microclimate analysis of sacred plant area

A multi-parameter analyzer was utilized to measure carbon dioxide concentration, temperature, and relative air humidity (model AZ-77535, AZ-instruments, made in China) following Treesubsuntorn and Thiravetyan (2018) with slight modification for fitting outdoor condition. The analyzer was kept stable at a height of 1 meter. The $CO_2$ concentration, air temperature and relative humidity under the canopy were measured at the distance of 4 meters from the sacred plant stem. It was compared to the tested parameters of air outside of the plant canopy at the distance of 20 meters from the plant stem. The measurement was repeated three different points for under and outside of the canopy. Paired samples T-test was conducted on all parameters under and outside of canopies. The wind speed was ignored, therefore the variable was not measured for this study.

### Bird existence observation

The existence of birds in the sacred area was noted based on their morphology and sound. Local names and specific characteristics of birds were obtained by an open-ended interview with Tengger people. Further, the data was confirmed to determine the bird scientific names.

## Results and discussion

### Locations and identity of sacred plants

The existence of the ties of Tengger family leads to

**Table 1:** Sacred area names and administrative locations

| Name | Location |
|---|---|
| Punden Wonosari | Wonosari Sub-village, Pandansari Village, Poncokusumo Sub-district, Malang City |
| Punden Drigu | Drigu Sub-village, Poncokusumo Village, Poncokusumo Sub-district, Malang City |
| Punden Poncokusumo | Poncokusumo Sub-village, Poncokusumo Village, Poncokusumo Sub-district, Malang City |
| Pedanyangan Perhutani | Perhutani's area, Poncokusumo Village, Poncokusumo Sub-district, Malang City |
| Pedanyangan Gunung Sari | Perhutani's area, Gubugklakah Village, Poncokusumo Sub-district, Malang City |
| Pedanyangan Gubuk Klakah | Gubugklakah Sub-village, Gubuk Klakah Village, Poncokusumo Sub-district, Malang City |
| Sanggar Pamujan Ngadas | Ngadas Sub-village, Ngadas Village, Poncokusumo Sub-district, Malang City |

preserve the local culture such as Kasada ceremony. Based on traditional beliefs, all of the hereditary activities is sourced from the greatness of the Creator, therefore, humans shall guard the natural environment. Places associated with cultural activities are referred to as punden, pedanyangan, and "sanggar pamujan (Purnomo, 2017; Batoro, 2017). Punden is defined as a sacred area for the graves of people who are considered as the forerunners of the village community. In addition, the term pedanyangan is defined as a sacred area that must be visited to prevent family members and village communities from distress. The area of pedanyangan has a certain area which is usually not extensive. The wide of an area and the plant diversity were managed accordingly to the village needs, especially for the cultural ceremony. Moreover, sanggar pamujan mean as a place of worship for the guardian spirit of the village (Batoro, 2011; Batoro, 2017). The above mentioned sacred areas are protected by cultural law and functioned as a protection of biodiversity.

The location of sacred areas was easy to be found since they were characterized by the large plants. Location of sacred areas and nomenclature of sacred plants were shown in table 2.

The sacred plants consisted of the genus Ficus and Casuarina which were grouped into family Moraceae and Casuarinaceae, respectively. Moreover, the sacred plants which were consisted of *F. callosa*, *F. ribes*, and *F. benjamina* could be growth at elevation 746-1,207 masl. However, the *C. junghuhniana* was growth at the area about 2,151 masl. Traditional people obtained the difference growing ability of Ficus and Casuarina plants based on their experiences, in which genus Casuarina was easily found at higher places than genus Ficus.Ficus plants were mentioned by Kunwar and Bussmann (2006) grew at elevation 100-1,800 masl except for *F. neriifolia*, *F. palmata*, and *F. sarmentosa* which grew at the elevation higher than 2,000 masl.

The growth of the sacred plants in the sacred area followed the specific arrangements. There were at least 4 different simplified arrangements of sacred plant as follows: (a) one or two plant(s) at one point, (b) two plants at two points, (c) three plants at three points accompanied with small praying house, and (d) multiple plants at multiple points accompanied with small praying house (Fig. 1). The local people just used the area under the sacred tree for praying when the praying house was not available.

The sacred plant arrangements were usually not by design. When a plant or several plants had been chosen as the sacred plant by the key person of Tengger Tribe, the society would follow the belief along with plants arrangement. Botanical analysis tends to highlight that the specific plant arrangements related to their canopy closure to protect area under the tree from solar radiation.

**Microclimate analysis of sacred plant area**

Regulation of outdoor thermal environment by trees is mostly through the canopies. The complex of canopies of trees prevent solar radiation to reach the ground, therefore, the heat storage underneath is reduced (Rahman *et al.*, 2017). From three different parameters which were observed in this study, the temperature values under canopy were significantly lower than outside canopy. However, the $CO_2$ concentration and relative humidity tend to be similar under and outside of the canopy (Table 3 and Table 4).

Previous research showed that the trees grown in urban conditions could affect temperatures through several processes such as interception of the solar radiation by tree canopies in which consequently prevent the underneath surface to adsorb shortwave radiation, tree canopies absorb solar radiation through evapotranspiration process, a single tree can influence the microclimate whereas the multiple trees can extend the effect to the surrounding environment. Moreover, a park can decrease the air

**Table 2:** The coordinate and latitude of sacred areas and the names of sacred plants

| Sacred area | Location coordinate | Altitude (masl) | Local name of the sacred plant | Plant scientific name |
|---|---|---|---|---|
| Punden Wonosari | 8°04'15.2" S 112°47'42.3" E | 746 | Ilat-ilat | *Ficus callosa* Willd. |
| Punden Drigu | 8°02'31.6" S 112°48'34.4" E | 822 | Preh | *Ficus ribes* Reinw. ex. Bl. |
| Punden Poncokusumo | 8°03'04.6" S 112°49'08.5" E | 937 | Ringin<br>Ilat-ilat | *Ficus benyamina* L.<br>*Ficus callosa* Willd. |
| Pedanyangan | 8°03'25.0" S 112°48'43.4" E | 876 | Ringin | *Ficus benyamina* L. |
| Pedanyangan Gunung Sari | 8°00'50.6" S 112°51'07.0" E | 1,207 | Ringin | *Ficus benyamina* L. |
| Pedanyangan Gubuk Klakah | 8°01'52.3" S 112°50'56.3" E | 1,110 | Preh<br>Ringin | *Ficus ribes* Reinw. ex. Bl.<br>*Ficus benyamina* L. |
| Sanggar Pamujan Ngadas | 7°58'51.2" S 112°54'43.4" E | 2,151 | Cemara gunung | *Casuarina junghuhniana* L. |

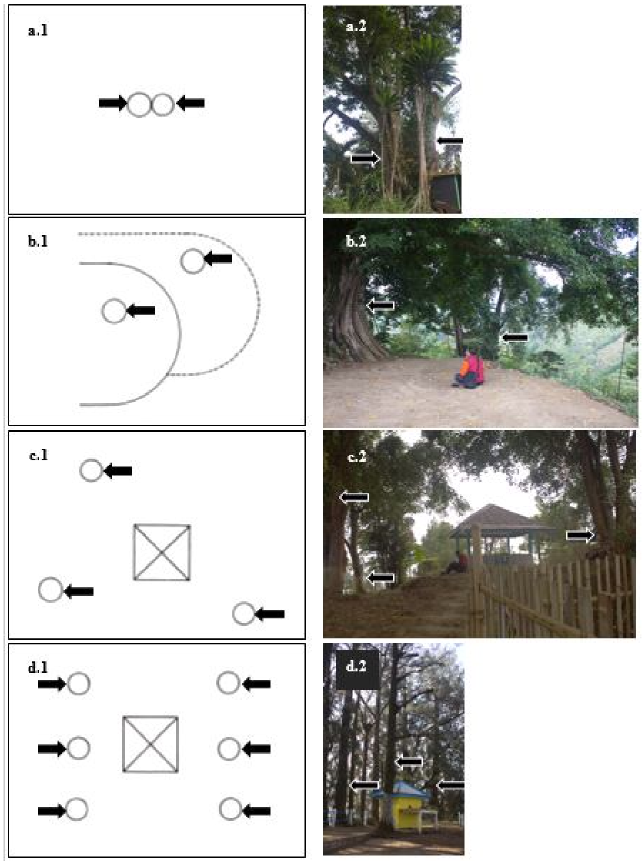


**Fig. 1:** The sacred plant arrangements. Top view (a.1) and side view (a.2) of one point, top view (b.1) and side view (b.2) of two points, top view (c.1) and side view (c.2) of three points, top view (d.1) and side view (c.2) of multiple points. The arrow indicated the sacred plant.

temperature about 0.94°C than outside (Oke, 1989; Yu and Hien, 2006; Bowler *et al.*, 2010; Rahman *et al.*, 2011; Kong *et al.*, 2016; Rahman *et al.*, 2017). It was similar to this study which showed the difference of temperature between under and outside the canopy about 1.0°C.

$CO_2$ concentration under and outside of plant canopy tend to be similar. Under the plant canopy, the ranges of $CO_2$ concentrations were 306-362 ppm, however, outside the plant canopy, the ranges of $CO_2$ concentration were 295-362 ppm. These conditions were similar to normal indoor conditions which contained 300-400 ppm of $CO_2$. Several unhealthy symptoms and diseases could be induced by more than 600 ppm of $CO_2$ (Satish *et al.*, 2012; Treesubsuntorn and Thiravetyan, 2018).

Moreover, relative humidity under and outside of plant canopy also tend to be similar. Under the plant canopy, the ranges of relative humidity were 39.3-75.0%, however, outside the plant canopy, the ranges of relative humidity were 46.8-75.1%. The relative humidity under plant canopy should be influenced by the cooling process of the plant through evapotranspiration (Rahman *et al.*, 2017). Due to the high deviation of relative humidity during measurements, the Paired samples T-test was not shown the significant difference of the parameter between under and outside canopy.

### The bird existence

We would like to underline that the presence of birds indicated the good environmental quality since birds is the most important wildlife for the environmental health condition (Idilfitri *et al.*, 2014). Open-ended interview with Tengger people indicated many birds coming to the sacred plant in fruit season. The local names of bird which were obtained during an interview and the scientific names were shown in table 5. With the temperatures under the sacred plant canopy were lower 1°C compared to outside, the plants might be the more comfortable places for bird habitation.

**Table 3:** Sacred areas and outdoor comfort parameters

| Sacred area | Time of observation (a.m.) | Plant scientific name | Under canopy | | | Outside canopy | | |
|---|---|---|---|---|---|---|---|---|
| | | | $CO_2$ (ppm) | T (°C) | RH (%) | $CO_2$ (ppm) | T (°C) | RH (%) |
| Punden Wonosari | 09.45 | *Ficus callosa* Willd. | 362±1 | 25.8±0.3 | 53.5±1.6 | 354±2 | 26.9±0.2 | 54.8±1.0 |
| Punden Drigu | 11.25 | *Ficus ribes* Reinw. ex. Bl. | 358±2 | 26.3±0.5 | 65.7±0.2 | 362±4 | 26.0±0.2 | 66.8±1.5 |
| Punden Poncokusumo | 12.05 | *Ficus benyamina* L.<br>*Ficus callosa* Willd. | 351±1 | 27.1±0.2 | 51.0±0.5 | 358±4 | 29.3±1.1 | 50.8±3.8 |
| Pedanyangan Perhutani | 14.15 | *Ficus benyamina* L. | 354±7 | 31.5±0.3 | 39.3±1.5 | 351±3 | 32.4±0.9 | 46.8±1.8 |
| Pedanyangan Gunung Sari | 11.45 | *Ficus benyamina* L. | 340±5 | 23.2±0.8 | 75.0±1.5 | 342±1 | 25.0±0.8 | 73.2±1.6 |
| Pedanyangan Gubugklakah | 13.15 | *Ficus ribes* Reinw. ex. Bl.<br>*Ficus benyamina* L. | 344±1 | 24.3±0.2 | 73.9±0.6 | 348±1 | 24.6±0.3 | 75.1±0.5 |
| Sanggar Pamujan Ngadas | 14.00 | *Casuarina junghuhniana* L. | 306±2 | 21.5±0.4 | 67.0±0.4 | 295±3 | 25.8±0.1 | 52.7±0.4 |

**Table 4:** The Paired T-test of $CO_2$ concentration, temperature and relative humidity between under canopy and outside canopy

| | 95% Confidence Interval of the Difference | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|
| | Lower | Upper | | | |
| Pair 1 $CO_2$ (under-outside) | -2.46935 | 3.99316 | 0.492 | 20 | 0.628 |
| Pair 2 T (under-outside) | -2.19266 | -0.79781 | -4.472 | 20 | 0.000 |
| Pair 3 RH (under-outside) | -1.81605 | 4.06367 | 0.797 | 20 | 0.435 |

**Table 5:** Diversity of birds around the sacred areas

| Local name | Scientific name | Family |
|---|---|---|
| Sriti | *Appus afinis* | Apodidae |
| Bido | *Spilornis cheella* | Accipitridae |
| Trocokan | *Pygnonotus squamatus* | Pygnonotidae |
| Kocomoto | *Zosterops montanus* | Zosteropidae |
| Emprit | *Lanchura leucogatroides* | Ploceidae |
| Gentilang | *Chloropsis sonerati* | Irinidae |
| Gagak | *Corvus enca* | Corvidae |
| Deluk | *Streptopelia chinensis* | Columbidae |

## Conclusions

The ranges of $CO_2$ concentrations, temperatures, and relative humidity under the sacred plant canopy were 306-362 parts ppm, 21.5-31.5°C, and 39.3-75.0%, respectively. However, outside the sacred plant canopy, the ranges of CO2 concentrations, temperatures, and relative humidity were 295-362 ppm, 24.6-32.4°C, and 46.8-75.1%, respectively. The key variable was the temperatures which differ between under and outside the canopy. In addition, this study provided locations and identity of sacred plants, the diversity of agricultural plants, and the diversity of birds around sacred areas. Although there are the fragmentation habitats, the existence of birds might indicate that the sacred plants were the comfortable places for their habitation.

## Acknowledgements

The authors would like to express their gratitude to the Faculty of Mathematics and Natural Sciences for financially supporting this study under DPP/SPP financial year 2018. The author also would like to thank Mr. Supardi (Dukun Pandhita), Mr. Ngatenan from Pandansari, and Tengger people for their support and discussion.

## References

Anthwal, A., N. Gupta, A. Sharma, S. Anthwal and K.H. Kim (2010). Conserving biodiversity through traditional beliefs in sacred groves in Uttarakhand Himalaya, India. *Resources, Conservation and Recycling,* **54**: 962-971.

Backer, C.A. (1968). van den Brink RCB. Flora of Java, Vol. I, II, III (Spermatophytes Only). Noordhoff, Groningen-The Netherlands.

Batoro, J., Keajaiban Bromo and Tengger Semeru (2017). Analisis kehidupan Suku Tengger-antropologi-biologi di lingkungan Bromo Tengger Semeru Jawa Timur. Indonesia: UB Press (in Indonesian).

Bowler, D.E., L. Buyung-Ali, T.M. Knight and A.S. Pullin (2010). Urban greening to cool towns and cities: A systematic review of the empirical evidence. *Landscape and Urban Planning,* **97**: 147-155.

Hakim, L. (2011). Cultural Landscapes of the Tengger Highland, East Java. In: Hong SK, Wu J, Kim JE, Nakagoshi N, editors. Landscape ecology in Asian cultures. Tokyo: Springer Japan; 69-82.

Idilfitri S, Sulaiman S, Salleh NS. Role of ornamental plants for bird community' habitats inurban parks; Procedia - Social and Behavioral Sciences 2014; 153:666-677.

Kong, F.H., W.J. Yan, G. Zheng, H.W. Yin, G. Cavan, W.F. Zhan, N. Zhang and L. Cheng (2016). Retrieval of three-dimensional tree canopy and shade using terrestrial laser scanning (TLS) data to analyze the cooling effect of vegetation. *Agricultural and Forest Meteorology,* **217**:22-34.

Kunwar, R.M. and R.W. Bussmann (2006). Ficus (Fig) species in Nepal: a review of diversity and indigenous uses; *Lyonia,* **11(1)**: 85-97.

Mirzamasoumzadeh, B. and V. Mollasadeghi (2013). Effcect of Osmotic stress on chlorophyll and proline differentwheat cultivar. *UCT Journal of Research in Science ,Engineering and Technology,* **1(4)**.

Pramita, N.H., S. Indriyani and L. Hakim (2013). Etnobotani upacara Kasada masyarakat Tengger di Desa Ngadas, Kecamatan Poncokusumo, Kabupaten Malang. *Journal of Indonesian Tourism and Development Studies,* **1(2)**:52-61.

Purnomo, Oktaviani AI and I. Nugroho (2018). The conservation based on the local people in Tengger community and its potential as ecotourism activities. *Journal of Socioeconomics and Development,* **1(1)**:7-15.

Oke, T.R. (1989). The micrometeorology of the urban forest; Philosophical Transactions of The Royal Society B. *Biological Sciences,* **324**:335-349.

Rahman, M.A., J.G. Smith, P. Stringer and A.R. Ennos (2011). Effect of rooting conditions on the growth and cooling ability of *Pyrus calleryana*. *Urban Forestry and Urban Greening,* **10(3)**: 185-192.

Rahman, M.A., A. Mose, T. Rötzer and S. Puleit (2017). Within canopy temperature differences and cooling ability of *Tilia cordata* trees grown in urban conditions. *Building and Environment,* **114**:118-128.

Rhee, S., K. Darrell. B. Tim, M. Reed, D. Russ and Stacey (2004). Report on biodiversity and tropical forests in Indonesia submitted in accordance with Foreign Assistance Act Sections 118/119, prepared for USAID/Indonesia. Indonesia.

Satish, U., M.J. Mendell, K. Shekhar, T. Hotchi, D. Sullivan, S. Streufert and W.J. Fisk (2012). Is $CO_2$ an indoor pollutant? Direct effects of low-to-moderate $CO_2$ concentrations on human decision-making performance. *Environmental Health Perspective,* **120**:1671-1677.

Taºbakan, M.I., R. Durusoy, S. Tosun, D. Akyol, H. Pullukçu and T. Yamazhan (2017). Relationship Between Tetanus Antitoxin Titration Level and Vaccination History. *J. Clin. Exp. Invest.,* **8(4)**: 104-9.

Treesubsuntorn, C. and P. Thiravetyan (2018). Botanical biofilter for indoor toluene removal and reduction of carbon dioxide emission under low light intensity by using mixed C3 and CAM plants. *Journal of Cleaner Production,* **194**:94-100.

Yu, C. and W.N. Hien (2006). Thermal benefits of city parks. *Energy and Buildings,* **(38)**:105-120.