Recommended plants for green open space to enrich bird diversity in Gedebage region Bandung West Java

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Abstract. Gedebage is projected to be the center of Bandung city government. A good urban plan must have at least thirty percent green open space in that area. Therefore, it is necessary to plant more trees on the Gedebage to increase green open space. To enrich bird diversity, the type of plants that planted on green open space must have added value as bird habitat. The aim of this study is to obtain a list of plants used by birds that are suitable and can grow well in the Gedebage. The method used was direct observation with line transect method to record plants species that used by birds in Bandung city park. Then the growth requirement of recorded plants was studied based on literature. This study shows only 21 species of 33 plants species that used by bird are suitable growing in Gedebage. Based on this research, we recommend 21 species of plants that are suitable to be planted in Gedebage that can increased number of green open space and also attract birds so that the diversity of birds in Gedebage can be increased. The results of this study can also be applied in areas with similar physical conditions to Gedebage.

1. Introduction

Bandung city government project Gedebage sub-district to be the center of Bandung city government and the Central Business District (CBD). Therefore, development in this area is ongoing on a large scale. In addition to build infrastructure, the government has also allocated a green open area as stipulated in the Gedebage Masterplan. Based on Indonesian Law No. 26 of 2007 concerning on urban spatial planning, green open space in an area ideally reaches 30% of the total area. The area of Gedebage sub-district is 979,308 Ha. Meanwhile, based on Bandung City Government data bank, Gedebage sub-district only has around 9.2 Ha of Green Open Space, it means that Gedebage need more green open space area. Green open space is very beneficial for human, in terms of socio-cultural, economic and ecological. Chiesura states that urban parks have social and psychological functions for humans [1]. Green Open Space as a social cultural service can be seen from its function as a means of recreation,
sports, education, and a means of activity for communities in urban areas. The economic function of the Green Open Space are energy savings, management of groundwater reserves, and the effect of green open space on the value of a property [2]. While several studies in Indonesia focus on the economic function of the Green Open Space as a source of income such as parking attendants, street vendors, janitors, toilet guards and security guards [3,4]. Ecologically, Green Open Space will help provide groundwater reserves through its vegetation. The vegetation also plays a role as suppliers of oxygen to humans and other living things. Green open spaces also function as habitat for animals that live in cities, such as squirrels, insects and birds. The ecological function of urban parks is often forgotten in city development plans. Even in urban garden designs. The design of a city park usually prioritizes the layout, beauty and social functions. The recommended types of plants are more aesthetic and shade functions. Only a few studies have recommended plant species that have ecological functions. Akbari et al recommend some plants as air quality enhancements in several large cities in the United States [5].

Research on urban garden design in the Gedebage sub-district has been conducted by Sagala et al [6]. They conducted research on urban garden based on 8 green city attributes formulated by the Ministry of Public Works through the Green City Development Program (P2KH). They recommend 10 species of plants that have ecological functions such as high water absorption ability, noise suppressor, shade, erosion prevention, micro climate guard, pollutant absorber, wind breaker, as a barrier and only two types have ecological functions as animal habitat. But not specifically explained which animals can use these plant types. Urban bird has an important role in urban ecosystem and food chain. Bird and vegetation have a high level of dependence on each other. Bird cannot live without plants and vice versa, many plant species need birds to carry on its life. Bird pollinator extinction highly influence on declining pollination, seed production and plant density [7]. As urban development continues, urban bird habitat is increasingly displaced. Planting trees and optimize vegetation vertically can enhance bird species richness and diversity [8]. To maintain and enrich urban bird population in city area, we can plant various vegetation that birds need. This research is expected to provide recommendations plants to be planted in green open spaces that can help conserve bird diversity in the city.

2. Method

2.1. Data collection
Observations were held in three city parks in Bandung which had the highest bird diversity namely Maluku Park, Kandaga Park, and Balai Kota Park [9]. Observations were made in each city park with 3 repetitions. Observations were made using line transect method. We walked along the transect and recorded all bird species seen, we also recorded bird activities and inventory plants species were used by bird. We observed birds by using Nikon Action 8x40 binoculars. The unknown plants species sample were preserved to be identified in the integrated laboratory of UIN Sunan Gunung Djati Bandung.

2.2. Data analysis
After we obtained a list of plants species that used by birds in Bandung city park, we analyses the growth factor requirements based on literature. After that, we matched those growth factor with environmental condition in Gedebage Sub-district. Gedebage has four areas, namely Cisaranten Kidul, Cimencrang, Rancanumpang, and Rancabolang. Based on Bandung city government data 2017, of the four eras, the only area that did not have green open space was the Cimencrang area. Therefore, the measurement of environmental condition factors was carried out in the open land in the Cimencrang area with the aim that this area will be one of the green open space areas. The measured physical environmental factors included the temperature and humidity of the air, soil pH, and wind speed. While other physical factors obtained from literature studies.
3. Result and discussion

3.1. Plant inventory

Based on observations in three city parks there are 33 species of plants used by urban birds to carry out their daily activities. The plants are classified into 3 categories based on their use for birds, namely food sources, shelter and nest. A literature study on each of these species was also conducted to obtain additional information on the use of these plants for bird life in nature. The following is a comparison diagram of the number of plant species used as a food source, shelter and nest.

![Comparison diagram of plant species use by birds](image)

Figure 1. Proportion of number of plant species based on their use by birds.

Figure 1 shows the proportion of plant species used by birds in carrying out their daily activities. Nevertheless, there are several plant species that are used to carry out more than one activity. Based on a literature study of 33 species of plants used by urban birds, 21 species have the potential to be a source of food for those birds. However, only 8 species were observed directly consumed by urban birds namely *Casuarina equisetifolia*, *Elaeocarpus serratus*, *Hamelia patens*, *Muntingia calabura*, *Spathodea campanulata*, *Ardisia humilis*, *Wodyetia bifurcate*, and *Arachis pintoi*. The potential as bird food source of 13 other species obtained from literature studies. Most of these plants are producing fruit, although some of them produce flower and nectar that consumed by bird. We observe *Arachis pintoi* flower consumed by *Passer Montanus*. *Passer montanus* known as omnivorous bird, they eat insect, seed and fruit, but there is no literature that states these birds eat flowers [10]. Some birds such as *Dendrocopos macei* and *Megalaima haemacephala*, was observed use a hole in an old tree to make a nest. There are also birds that build nests by gathering and arranging branches on the tree. Based on observations and literature studies, 8 species of plants have the potential to be used as bird nests. Those 8 species are *Pterocarpus indicus*, *Agathis alba*, *Cassia fistula*, *Swietenia macrophylla*, *Khaya anthotheca*, *Pinus merkusi*, *Alstonia scholaris*, and *Schima wallichii*. All of those plants is a tall tree. nest height influences egg laying success, nests placed at lower altitudes are more at risk than nests placed on higher trees [11]. 10 species plants used as shelter for resting. During the observation these plants were not only used as shelter, but also for social activities such as playing and mating. Most of the shelter tree has a wide canopy and evergreen. This characteristic help bird protecting itself from predator and extreme weather [12].

3.2. Growth factor requirements analyses

Gedebage is located in East Bandung. Based on 2015 government data, Gedebage especially in Cimencrang is located at 750m above sea level. This area has a rainfall of 240mm / year, with lowland topography. Soil types in the Gedebage area are soft clay soils. Other environmental factors that are measured directly can be seen in Table 1 below.
Table 1. Gedebage physical environmental factors.

| No | Physical Factor          | Average   |
|----|--------------------------|-----------|
| 1  | Temperature              | 27.2 °C   |
| 2  | Air Humidity             | 59%       |
| 3  | Soil pH                  | 7.8       |
| 4  | Minimum wind speed       | 1 m/d     |
| 5  | Maximum wind speed       | 4.1 m/d   |

Gedebage area has a type of soft clay soils with high light intensity due to the lack of shade vegetation, low air humidity and soil pH that tends to be alkaline. Based on the analysis of the suitability of physical factors and growing requirements, not all types of plants used by urban birds can grow in the Gedebage area. Of the 33 plant species observed used by birds in city parks, only 21 are suitable. A list of these plant types is in table 2 below.

Table 2. Types of recommended plants.

| No. | Species                  | Food Source | Nest | Shelter |
|-----|--------------------------|-------------|------|---------|
| 1   | Pterocarpus indicus      | √           | √    |         |
| 2   | Ficus benjamina          | √           |      |         |
| 3   | Bougainvillea spectabilis| √           |      |         |
| 4   | Bauhinia purpurea        | √           |      |         |
| 5   | Casuarina junghuhniana   | √           |      |         |
| 6   | Agathis alba             | √           |      |         |
| 7   | Cassia fistula           | √           |      |         |
| 8   | Aleurites moluccana      | √           | √    |         |
| 9   | Canarium indicum         | √           | √    |         |
| 10  | Filicium decipiens       | √           |      |         |
| 11  | Muntingia calabura       | √           |      |         |
| 12  | Terminalia catappa       | √           |      |         |
| 13  | Swietenia macrophylla    | √           | √    |         |
| 14  | Wodyetia bifurcata       | √           |      |         |
| 15  | Caesalpinia pulcherrima  | √           |      |         |
| 16  | Pinus merkusii           | √           |      |         |
| 17  | Alstonia scholaris       | √           |      |         |
| 18  | Schima wallichii         | √           |      |         |
| 19  | Arachis pintoi           | √           |      |         |
| 20  | Manilkara kauki          | √           |      |         |
| 21  | Callistemon viminalis    | √           |      |         |

Twelve of those 21 plants species is bird food source. some of them produce fruit, seed, nectar and flower that consumed by bird. Those plants and insect attracted plants can increase bird diversity [12].

*Pterocarpus indicus* is a plant that is widely used as a nesting place by birds. The widened canopy is very important as a cover / shelter from the weather and predators. Many bird nests were found in the canopy of trees between the twigs which were tightly arranged. In addition to nesting, many birds use this tree to play, chirp and rest. *Ficus benjamina* is a tree that has a very wide and leafy canopy, so it is suitable to be a shelter. We observed several small birds such as *Gerygone sulphurea, Aegithina viridissima* and *Dicaeum trochileum* are resting there. This plant is also classified as a food source, birds such as takur (Megalaimidae), pigeons, hornbills, perkici (Cyclopsittacini) and Pycnonotidae that are almost completely alive from this fruit in the fruit season. *Bougainvillea spectabilis* flowers are a food source for hummingbirds, but at the time of observation there were no nectarivorous birds that were
consuming their nectar. Similar to *Bougainvillea spectabilis* flowers, *Bauhinia purpurea* flowers can also invite hummingbirds to come. *Casuarina junghuhniana* is a food source tree for parrots. *Agathis alba* has a tall tree stature, the canopy is not too wide. But this tall tree makes this tree suitable as a nesting place. One of the birds that nest in this tree is the hornbill [13]. *Cassia fistula* is used as a place for *Nectarinia jugularis*, *Passer montanus*, and *Treron vernans*. *Aleurites moluccana* tree has a wide canopy, this tree is often used as a shelter by birds such as finches and also sparrows. The activity of eating fruit from this tree was not observed. Canary tree (*Canarium indicum*) has three categories of functions, during observation this tree is used as a shelter and nest and based on Thomson and Evans, this tree produces fruit that can be consumed by birds and bats [14]. *Filicium decipiens* is very popular with small birds for their activities. Several species have been recorded pecking insects in the branches of their trees. Cherry tree (*Muntingia calabura*) is known as a tree as a source of bird food. The fruit is well-liked by frugivorous birds, such as the Pycnonotidae and *Dicaeum trochileum*. *Terminalia catappa* usually live on the cost and lowlands, the fruit of this plant is consumed by birds and bats, but during the observation it was not recorded the bird activity used the fruit of this plant [14]. *Swietenia macrophylla* is used by birds as a place of rest, breeding, and protection for turtledove. *Wodyetia bifurcata* fruit is widely consumed by crooked beaks, such as parrots, but it is also recorded as being consumed by *Pycnonotus aurigaster* and turtledoves. Pine is a place to find food, nest or other activities such as perch / mating by certain bird species that are adaptive to the pine environment as examples *Streptopelia chinensis* [15]. *Manilkara kauki* fruit is an important food for various frugivores, especially birds. pairing the last species, *Callistemon viminalis*, attracts many birds because it is rich in nectar.

4. Conclusion
There are 21 species of plants that have the potential to increase the diversity of bird species in the Gedebage area, this type of plant is useful as a food source, shelter and also a place to build nests for urban birds. So this 21 types of plants are recommended to be planted in an area of green open space in the Gedebage area.

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References
[1] Chiesura A 2004 The role of urban parks for the sustainable city *Landscape and Urban Planning* 68 1 129–138
[2] Sadeghian M M and Vandanyan Z 2013 The Benefits of Urban Parks, a Review of Urban Research *Journal of Novel Applied Sciences* 8 2 231–237
[3] Faiqoh N E 2013 Nilai dan Manfaat Ekonomi Keberadaan Taman Kota Menteng, Jakarta Pusat, Sebagai Salah Satu Pemanfaatan Ruang Terbuka Hijau (Institut Pertanian Bogor: Report)
[4] Etingingsih E 2006 Fungi Taman Kota Sebagai Ruang Publik (Universitas Lampung: Report)
[5] Akbari H, Pomerantz M and Taha H 2001 Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas *Solar Energy* 70 3 295–310
[6] Sagala A R, Prasetyo A, Syakur D A, Amania N R, Radnavati D and Syahadat R M 2017 Perencanaan Taman Kota sebagai Salah Satu Atribut Kota Hijau di Kecamatan Gedebage, Bandung *Jurnal Arsitektur, Bangunan dan Lingkungan* 6 3 85–90
[7] Sandra H A, Dave K, Jenny J L, Sue M and Jon T 2011 Cascading Effects of Bird Functional Extinction Reduce Pollination and Plant Density (New York: Science)
[8] Simone F, Thomas S, Fabio B and Marco M 2011 How to manage the urban green to improve bird diversity and community structure *Landscape and Urban Planning* 278-285
[9] Endah G P and Partasasmite R 2015 Keanekaan Jenis Burung di Taman Kota Bandung, Jawa
Barat Pros Sem Nas Masy Biodiv Indon 1 6

[10] Mchugh N M, Prior M, Leather S R and Holland J M 2016 The diet of Eurasian Tree Sparrow Passer montanus nestlings in relation to agri-environment scheme habitats Bird Study 63 2 279–283

[11] Li P and Martin T E 1991 Nest-site selection and nesting success of cavity-nesting birds in high elevation forest drainages The Auk 108 2 405-418

[12] Sabrina I, Suria S and Nur S S 2014 Role of Ornamental Plants for Bird Community’ Habitats in Urban Park Procedia Socio Sci 22 2 666-677

[13] Wardani M and Heriyanto N M 2015 Autekologi Damar Asam Shorea hopeifolia (F. Heim) Symington di Taman Nasional Bukit Barisan Selatan, Lampung Plasma Nutfah 21 2 89-98

[14] Thomson L A and Evans B 2006 Canarium indicum var. indicum and C. harveyi (canarium nut) Traditional Trees of Pacific Islands: Their Culture, Environment and Use 209-226

[15] Widodo W 2011 Studi Keanekaan Spesies Burung pada Tiga Tipe Tata Guna Lahan di Taman Wisata Alam Gunung Pancar, Bogor Proceeding Biology Education Conference: Biology, Science, Enviromental, and Learning 10 1