

Impact of agricultural crop type and hunting on bird communities of two villages in Bandung, West Java, Indonesia

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Manuscript received: 9 October 2019. Revision accepted: 4 December 2019.

Abstract. Hakim L, Abdoellah OS, Parikesit, Withaningsih S. 2020. Impact of agricultural crop type and hunting on bird communities of two villages in Bandung, West Java, Indonesia. *Biodiversitas* 21: 57-66. Land use change has occurred in the Upper Citarum Watershed over time, converting tropical rain-forest to man-made cash-crop gardens dominate the agricultural landscape, leaving mixed-garden (*talun*), rice fields and smallholder plantation. This changes species composition, community structure and animal diversity, especially bird species. The objective of this paper was to study bird structure community in rural agricultural landscape in Upper Citarum Watershed. We conducted the survey from February to March 2018. We surveyed birds at 36 point counts (PCs), each PC's surveyed six times for 15 minutes along total 6 km of transects in the agricultural landscape in Sukapura and Resmi Tingal Village, consisting of 12 PCs in mixed-garden, 12 PCs in homegarden and 12 PCs in cash-crop garden. Twenty-nine bird species, 17 families and 1.103 individuals were recorded; 2 species being protected by Indonesian law in all sites, three Javan Island endemics and one species migrant bird species. The insectivorous birds are dominant with 15 species in all land-use types. *Passer montanus* and *Javan munia* were the most common birds in all land-use types with 820 of 1.103 individual birds (74,9%) were of two bird species. Mixed-garden had higher bird diversity, species richness, and evenness index than the homegarden and cash-crops garden because of the complexity of vegetation structure and canopy cover stratification. There was a significant decrease in some bird species which in the previous study was dominant to be reduced even to local extinctions such as Oriental White-eye (*Zosterops palpebrosus*), Crescent-chested Babbler (*Stachyris melanothorax*) and Western Yellow Wagtail (*Motacilla flava*). Decreased bamboo-tree garden as Crescent-chested Babbler habitat is suspected to be the cause of declination of this bird population. In addition, unregulated bird hunting is also one of the causes of the declining bird populations, especially birds with market value. Some species such as Oriental White-eye (*Zosterops palpebrosus*), Sooty-headed Bulbul (*Pycnonotus aurigaster*), Great Tit (*Parus major*), Bar-winged prinia (*Prinia familiaris*), Javan myna (*Acridotheres javanicus*) and Spotted dove (*Streptopelia chinensis*) have rapidly decreased population because of bird hunting activities.

Keywords: Agricultural landscape, bird, diversity, upper Citarum watershed

INTRODUCTION

Citarum watershed with intensive agricultural activities, especially in the upper part, is one of the 108 critical watersheds priority to restore its carrying capacity in Indonesia (Ditjen PDASHL 2015). Land use change due to agricultural expansion has converted tropical forests into agricultural areas and settlements and has become a common practice in the Upper Citarum Watershed (UCW) (Parikesit et al. 2005; Abdoellah et al. 2006). Since the end of the 1970s, there was a tendency that communities began converting bamboo-tree gardens, rice fields and smallholder plantations into commercial agricultural land (cash-crops/vegetables) and also for settlements (Gunawan et al. 2002). Moreover, plantation, rice fields and bamboo-tree gardens (*talun*) has the function of increasing the environmental carrying capacity, for instance to minimizing run-off and preventing landslides. In addition, mixed-garden (*talun*) and homegarden also have economic,

socio-cultural, aesthetic and landscape functions (Soemarwoto and Conway 1992; Abdoellah 2017).

Newbold et al. (2015) pointed out that land use change due to agricultural expansion is widely known as one of the key drivers of biodiversity loss in the tropics. Land use change into large-scale commercial agriculture not only eliminates the practice of shifting cultivation, but also decreases biodiversity and soil fertility, also increasing soil erosion in agriculture in Southeast Asia (Rerkasem et al. 2009). Land use change in the UCW impacted habitat loss for animal that affects bird biodiversity. Birds have been widely used as bio-indicators for environmental change, and increased agricultural intensity is closely related to the decline in populations of various bird species in Europe, North America, Africa and Asia (Tabur and Eyvaz 2010). A lot of birds have been threatened in rural ecosystems of Indonesia, including in West Java in the last several decades. Consequently, some bird species have been recorded became rare or locally extinct (Iskandar 2016).

In addition, bird hunting is also increasingly common, especially in rural areas. The songbird contests activity and bird trading in the urban area have caused of unregulated bird hunting and trapping in the village areas. Consequently, the population of some songbird species has become very rare and a high risk to be extinct in nature due to over-exploitation for the bird trading in the urban area (Iskandar and Iskandar 2015).

Birds are good bio-indicators from land-use changes. Their sensitivity to changes in the ecosystem can be a strong indicator of the species richness and of the presence of certain plant species. The use of birds as bio-indicators can explain to what extent human activities have changed habitat quality and how this change has affected biodiversity (Chambers 2008). Avian communities are used as bio-indicators because taxonomically they are well identified, easy to observe, sensitive to changes in habitat quality, and among the key players in ecosystem functioning by acting as pollinators, predators, seed dispersers, scavengers, and ecosystem engineers (Sekercioglu 2006; Tschardt et al. 2008). Birds also have beneficial impacts on agroforestry systems because they can suppress arthropod density, thus increasing the yield of palm oil (Maas et al. 2013). Agroforests in human modified landscapes play an important role to conserve biodiversity (Jose 2012; Bardhan et al. 2012).

Studies on the condition of bird species diversity in the UCW were undertaken by several scholars. The first study was carried out by Erawan et al. (1997) and Husodo (2006). The objective in this research was to study the impact of agricultural crop type and hunting on bird communities in rural agricultural landscapes in the UCW, especially in Sukapura and Resmi Tingal Villages in the dominant land use at this time, namely cash-crop garden, homegarden and mixed-garden (*talun*). This research was designed to see how changes in bird diversity compare to previous study that was conducted and also to determine the impact of agricultural crop type and bird hunting activities on bird species composition and bird status on feeding guild structure.

MATERIALS AND METHODS

Study area

The study was conducted in Sukapura and Resmi Tingal Villages, Sub-district (*kecamatan*) of Kertasari, Bandung, West Java, Indonesia (07°04'00"- 07°10'30" S and 107°40'30" - 107°44'45" E; altitude 1.000 - 1.250 meters above sea level (ASL)). In the past, both villages are one area village, namely Sukapura, but in 2012, Sukapura was divided into 2 villages, Sukapura dan Resmi Tingal. Both villages are located in the upper side of the largest and longest river in West Java, Citarum Watershed, and have great natural advantages to cultivate different kinds of crops (Abdoellah et al. 2006).

Materials

Some materials were used in this study including the field guide books for bird identification, written by

MacKinnon et al. (2010). In addition, birds were observed with binoculars, location of point counts was measured by GPS.

Habitat description

Mixed-garden (Talun)

Mixed-garden (*Talun*) were spread in two villages with a total of 12 point counts (PCs), consisting of Sukapura Village (6 PCs) and Resmi Tingal Village (6 PCs). *Talun* is dominated by bamboo, eucalyptus (*Eucalyptus alba*) and fruits, including Jackfruit (*Artocarpus heterophyllus*), Avocado (*Persea americana*), Guava (*Syzygium densifolia*), Coffee (*Coffea arabica*) and Sugar palm (*Arenga pinnata*). There are three types of bamboo that can be found in Sukapura Village, namely Awi temen (*Gigantochloa atter*), Awi tali (*Gigantochloa apus*) and Awi ageung (*Gigantochloa verticillata*) (Parikesit et al. 2005).

The existing *talun* is the remaining *talun* which widely available in Sukapura Village in the past. *Talun* is still maintained because it has an important role for the community, especially as wellspring, erosion and landslide retention because most of it located on steep slopes and public cemetery (graveyard). Some of the existing *talun* conditions have been converted into cash-crop gardens. *Talun* is fragmented into small patches between cash-crop gardens which are the dominant land uses in Sukapura Village and Resmi Tingal Village.

Homegarden

Homegardens were spread in the two villages with a total of 12 point count (PCs), consisting of 6 PCs in Sukapura Village and 6 PCs in Resmi Tingal Village. In general, the vegetation in homegarden is dominated by fruits, including avocado (*Persea americana*), jackfruit (*Artocarpus heterophyllus*), guava (*Syzygium densifolia*), coffee (*Coffea arabica*) and mango (*Mangifera sp.*). Wood plants can also be found in the Homegarden, although not in large numbers, including types of Eucalyptus (*Eucalyptus alba*) and Jabon (*Anthocephalus cadamba*).

Most of homegardens at the research site has also been converted into vegetable garden because of the limitations of cash-crop garden owned by farmers and to increase the economic value of the Homegarden.

Cash-crop garden

The cash-crop garden consists of 12 point counts (PCs), 6 PCs in Sukapura and 6 PCs in Resmi Tingal Village. Cash-crop gardens in both villages are dominated by green onion (*Allium stulosum*), carrots (*Daucus carota*), celery (*Apium graveolens*). These cash-crop gardens are permanent, most of them are originally converted from rice fields and mixed-garden (*talun*). Now, cash-crop gardens are the dominant land-use in the research site.

Methods

The method used in this study was mixed-method, combination of qualitative and quantitative methods with ethnoecological approach (Iskandar 2012a; Albuquerque et al. 2014; Iskandar et al. 2019). Quantitative data were

collected from February to March 2018 using point count method with limited distance (Bibby et al. 2000; Volpato et al. 2009). Total birds were collected in 36 point counts, representing mixed-garden (12 points), homegarden (12 points) and the cash-crop gardens (12 points) in both villages. We surveyed birds in two transect line along 1.000 meters for each land-use, each point was 200 m from others to avoid counting the same individual twice (Bibby et al. 2000; Husodo 2006). In each point, researcher recorded all birds seen or heard in 15 minutes with an

observation radius of 50 m. All point was visited in the morning from 6.00 to 9.00 and in the afternoon from 15.00 to 18.00 (twice a day). We repeated the observations for three days at the same point (total six times observation for each point) to maximize the number of bird species recorded. Rainy days and stronger wind were avoided. We used binoculars and cameras to observe the birds and field guide books for bird identification. The results are used to determine the diversity of species and the relative abundance of birds at the study site.

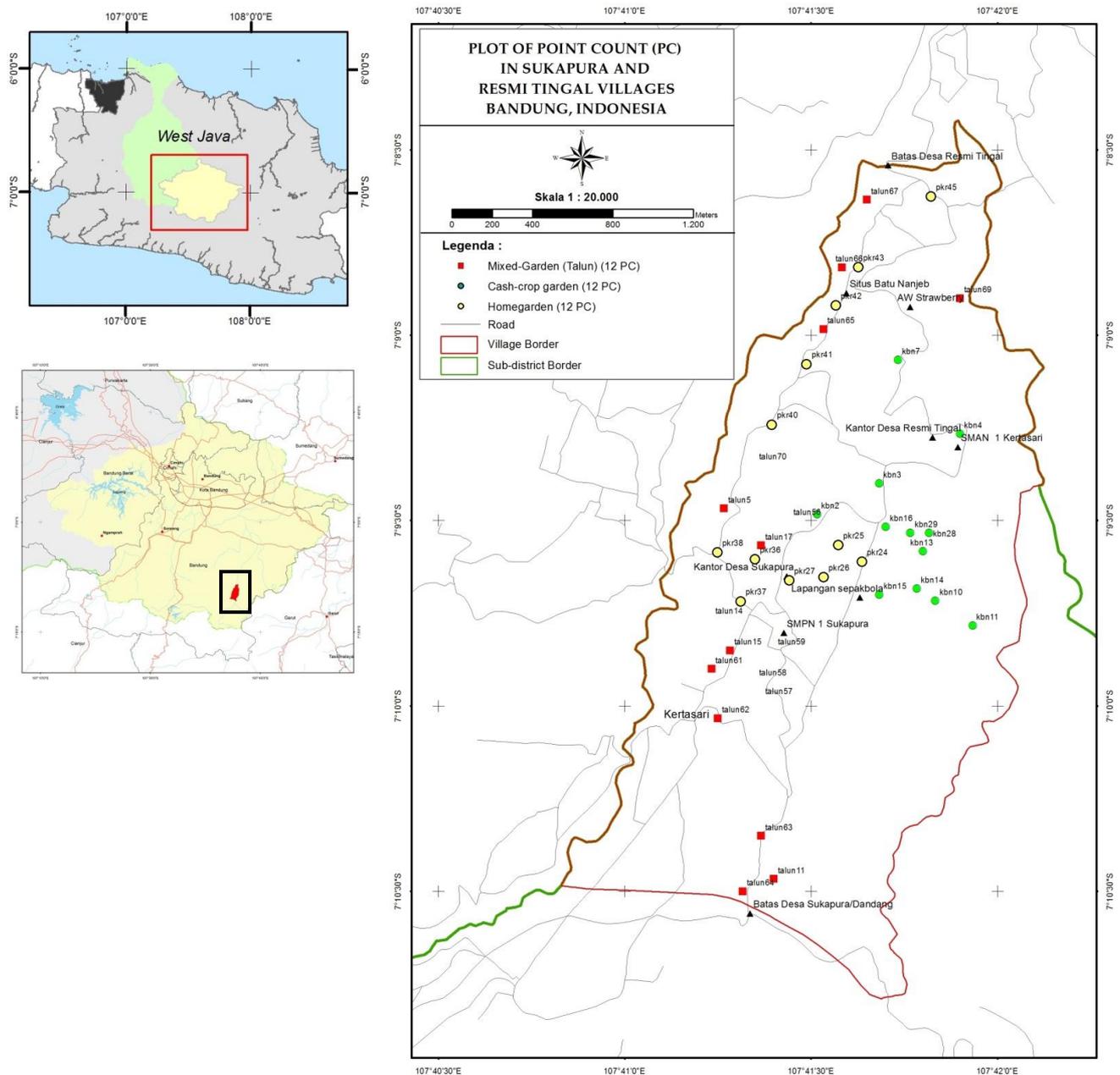


Figure 1. Research Location and Point Count (PC) Plots for bird biodiversity survey in Sukapura and Resmi Tingal Villages, Sub-district of Kertasari, Bandung, West Java, Indonesia



Figure 2. Habitat condition of land-use type in Upper Citarum Watershed. A-B Mixed-garden (*Talun*). C-D Homegarden, and E-F Cash-crop garden

Qualitative data collection techniques were conducted by direct observation and semi-structured interviews with competent informants including bird hunters, wild bird keepers, bird traders that are purposively selected by snowball techniques (Newing et al. 2011; Albuquerque et al. 2014). The interviews were designed specifically to understand the scale (extent) of bird captures and trade in the study area. Some aspects were discussed with informants, including local name, bird prices, bird hunting technique (time, tools, number of people, methods), the origin of bird acquisition, bird trading route and hunting income.

Species composition was determined by the list of species found in each point count. Bird relative abundance has closely related to the dominance of bird species in each land-use type (dominance index). Dominance Index of each bird (Di) calculated by number of individual of a species divided by total number of all individuals multiplied by 100% (Van Helvoort 1981; Iskandar et al. 2016). Moreover, bird population can be divided into 3 categories: $Di = 0-2\%$ (non-dominant), $Di = 2-5\%$ (sub-dominant), and $Di = \text{over } 5\%$ (dominant) (Iskandar et al. 2016). Birds that have a high dominance index in this study will be compared with previous studies. The Shannon-Wiener Index (H') was used to estimate species diversity (Krebs 1989; Magurran 2004). We used Margalef Species Richness Index (Dmg) to estimate species richness. Margalef index has the ability to respond to differences in species and has high sensitivity (Magurran 2004). The Evenness Index (E') was used to estimate the evenness for species richness between site types (Krebs 1989; Magurran 2004).

Feeding guild analysis and bird conservation status were analyzed using descriptive analysis. Feeding guild

analysis refers to MacKinnon et al. (2010). Bird conservation status refer to Ministry of Environment and Forestry Regulation (PerMenLHK) No.106/2018 about Preservation of plant and animal species (i.e. P = Protected; Unp = Unprotected) (Ministry of Environment and Forestry 2018), IUCN Red List (i.e. LC = Least Concern; NT = Near Threatened; NE = Not Evaluated) and CITES Appendices (Convention on International Trade in Endangered Species of Wild Fauna and Flora) (Appendix I: lists species that are the most endangered among CITES-listed animals and plants; Appendix II: species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled; Appendix III: is a list of species included at the request of a Party that already regulates trade in the species and that needs the cooperation of other countries to prevent unsustainable or illegal exploitation).

RESULTS AND DISCUSSION

Bird hunting as a strategy to increase income

Traditionally hunting wild animals, including hunting birds, have been recognized for a long time in rural area in West Java (Iskandar et al. 2016). Based on Semi-structured interviews with informants of both villages, bird hunting had been commonly practiced by local people in the past. At present, their hunting activities have tended to decrease because of bird population is lesser abundant. Bird hunting currently occurred in protected forests and conservation areas near both villages.

Table 5. Commonly hunted bird species and selling prices in both villages

English name	Local name	Scientific name	Selling price in the village (Rupiahs)	Hunting location
Oriental White-eye	<i>Kacamata Biasa</i>	<i>Zosterops palpebrosus</i>	10.000 - 25.000	Village
Mountain White-eye	<i>Kacamata gunung</i>	<i>Zosterops montanus</i>	10.000 - 25.000	Village
Bar-winged Prinia	<i>Ciblek</i>	<i>Prinia familiaris</i>	10.000 - 25.000	Village
Long-tailed Shrike	<i>Towed</i>	<i>Lanius schach</i>	100.000	Forest and village
Sooty-headed Bulbul	<i>Cangkurileung</i>	<i>Pycnonotus aurigaster</i>	150.000	Village
Yellow-vented Bulbul	<i>Jogjog</i>	<i>Pycnonotus goiavier</i>	100.000	Village
Srigunting hitam	<i>Saeran</i>	<i>Dicrurus macrocercus</i>	200.000	Forest
Anis merah	<i>Anis</i>	<i>Zoothera citrina</i>	500.000	Forest

Notes: 1 US Dollar = Rp. 14.000,-

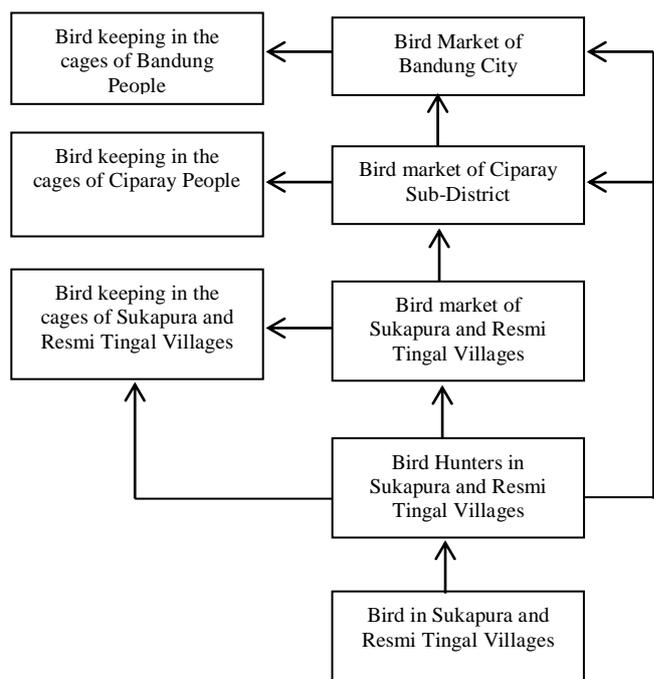
Massive bird hunting in Sukapura and Resmi Tingal Village occurred in 2009-2012 where there was an increase in demand for birds that were previously not a valuable bird such as Oriental White-eye (*Zosterops palpebrosus*), Bar-winged prinia (*Prinia familiaris*) and several types of songbird which began trading even though it's cheap. As a result, the populations of some birds in the rural area have rapidly decreased due to overexploitation. In the study of Erawan et al. (1997) and Husodo (2006) showed that Oriental White-eye was the dominant bird (having a high dominance index) in Talun and Homegarden in Sukapura Village. However, in this study, Oriental White-eye was not found at all. No Oriental White-eye was recorded at all in our study, suggesting it may now be locally extinct. Eaton et al. (2015) explain that Oriental White-eye is one of species that declining population in response to trade. Chng et al. (2015) pointed out that Oriental White-eye is the most numerous bird species found in Jakarta's bird markets.

According to the key informant that birds were previously abundant in the village, currently difficult to find, include: Oriental White-eye (*Zosterops palpebrosus*), Sooty-headed Bulbul (*Pycnonotus aurigaster*), Great Tit (*Parus major*), Bar-winged prinia (*Prinia familiaris*), Javan myna (*Acridotheres javanicus*) and Spotted dove (*Streptopelia chinensis*). Unrecorded birds, that are either very rare or now locally extinct (extirpated). This shows that unregulated bird hunting is a threat to the preservation of certain species, especially those that have high selling value. Commonly hunted bird species and selling prices in both villages can be seen in Table 5.

Culturally, there is some traditional technique to catch the bird in both villages and have similarities with local people of Karangwangi in Cianjur. Iskandar et al., (2016) pointed out that some techniques are predominantly practiced by local people, namely to glue birds with sap (*ngaleugeut/ngelem*), to capture birds by nets (*ngajaring*), to catch birds with torch and kerosene lamp (*ngobor*), to hunt with a bamboo blowpipe (*susumpit*), and to hunt with a gun (*bebedil*). On the basis of semi-structured interviews with informants, local people of both villages mostly using nets to capture the bird (*Ngajaring*). Nets are placed in areas where many birds such as forest, riverbank and rice field. Bird hunters usually play recorded bird sounds from cell phones loudly to attract the bird, then wait several hours while monitoring birds caught in the net. Birds that were caught in the net will be taken and placed in the cage

that has been prepared. The results obtained averaged 10-60 birds. The birds obtained will be sold to the bird keepers (middle man) in the village or taken directly to the bird market in Ciparay or Bandung. Eaton et al. (2015) mention that commercial trade represents a major threat to bird species and subspecies in Sumatra, Kalimantan, Java and Bali, Indonesia. The trading chain of birds from both villages can be seen in Figure 3.

Bird keepers are people who like to keep birds and hobbies for bird contests. The bird contest is a routine activity held by bird keepers at different times. At the local level, it is usually held every week, the regional level is held once every three months and the national level is held once a year (Iskandar and Iskandar 2015). Bird hunting motivation is to get additional income. Bird hunting is carried out in groups of 5-6 people. The majority of bird hunters are farm-workers (*buruh tani*) who do not have or have small agricultural land. Bird hunting is usually done when not working as farm-worker or when opening agricultural land in the forest.

**Figure 3.** Trading chain of bird in Sukapura dan Resmi Tingal Villages, Bandung, Indonesia

Bird species richness

We recorded 1.103 individual birds from 29 bird species from all sites. The most number of bird species was found in mixed-garden (*talun*) with 25 species. We found 17 species in homegarden and 13 species in cash-crop gardens (Table 1). Eurasian Tree Sparrow and Javan Munia were the most common birds in all land-use types. 820 of 1.103 individual birds (74,9%) were of two bird species. Eurasian Tree Sparrow (49,2% from total individual bird) is not native Indonesian bird, but introduced from Europe. Javan munia was categorized as paddy seed eaters and was culturally perceived by local people as notorious bird (Iskandar et al. 2016). Apart from those two birds, this study found very few records-individual of other species.

Higher bird species richness was found in mixed-garden (*talun*) related to the complexity of vegetation structure which consisted of different plant growth forms that contributed to canopy stratification in this habitat. More complex habitats are known to increase the diversity of species (MacArthur 1961; Erawan et al. 1997). Muhammad et al. (2013) pointed out that the mixed-tree agroforests maintained high species diversity of various functional groups of birds, despite being located close to village settlements and frequently visited by farmers.

Hadikusumah et al. (2008) explained that *talun* has a layered vegetation structure and high plant diversity. Parikesit et al. (2005) pointed out that the dominant types of mixed-garden vegetation in Sukapura were wood species namely kalices (*Eucalyptus alba*), montana selong (*Albizia montana*), kaliandra (*Calliandra calothyrsus*) and kastuba (*Euphorbia pulcherrima*). While the type of bamboo that dominates is awi temen (*Gigantochloa atter*), awi tali (*Gigantochloa apus*) and awi ageung (*Gigantochloa verticillata*). Although the current *talun* condition in Sukapura Village and Resmi Tingal Village has been greatly reduced, its role as a habitat for birds is very important. Parikesit et al. (2005) also explained that the existing *talun* in Sukapura is an important habitat for wildlife, especially birds and insects.

Observation in all locations shows that Sylviidae and Ploceidae are the families with the largest number of bird species, six bird species (20.7%) and three species (10.4%) respectively. The high population of these two families related to the level of adaptation and high mobility in each land-use type. In addition, abundant availability of feed causes birds that are generally small in size to have a high population (MacKinnon et al. 2010). The vegetation structure of mixed-garden (*talun*) floor which is dominated by bush and herbaceous has the potential to provide insects which are the main food of the Sylviidae family (Husodo 2006).

In accordance with feeding guilds, the insectivorous birds are dominant with 15 species (51%) in all land-use types. The high insectivorous bird species found related to the distribution and high insect population. This means that the area is most suitable for insectivorous birds. Mixed-garden (*talun*) and homegarden have the same number of insectivorous birds with 9 species, while in cash-crop garden only found 7 species. Insectivorous birds that feed on harmful insects and other pests in agro-ecosystems are

beneficial to agriculturists (Rajashekara and Venkaesha 2014). Insectivorous birds act as important biological control agents of insect pests in agriculture, floriculture, horticulture and forests (Thakur et al. 2010, Gunawan et al. 2016).

Carnivorous birds are a group of birds with the lowest number of species, with only Crested Hawk-Eagle and Crested Honey Buzzard. Carnivorous birds can only be found in mixed-garden (*talun*) which borders the Perhutani protected forest near the Cihejo river. These two species of birds were found soaring and then perched on Eucalyptus trees. All of carnivorous bird is protected by law (PermenLHK no.106/2018) because of their important role in the food chain of ecosystems.

Bird dominance index

Table 2 shows that the species of Eurasian Tree Sparrow and Javan Munia were very abundant in all sites. The dominance index value of the Eurasian Tree Sparrow in the mixed-garden (*talun*), homegarden and cash-crop garden was 29.04%; 50.88%; and 64.15%, respectively. While for Javan Munia, the dominance index value was 28.68%; 27.29% and 20.75%. This indices both of birds have the ability to live in various habitats, closely associated with humans and living in groups around the house, so that they were not too disturbed by human presence. Eurasian Tree Sparrow is a type of bird that flies colony and often forages on the ground and agricultural land by pecking at small or hard seeds (MacKinnon et al. 2010).

Mixed-garden (*talun*) has 5 dominant bird species, namely Eurasian Tree Sparrow, Javan Munia, Javan Kingfisher, Olive-backed Sunbird, and Spotted Dove, while homegarden and cash-crop garden has 2 dominant bird species, Eurasian Tree Sparrow and Javan Munia (Table 2). The existence of endemic bird species such as Javan Kingfisher in mixed-garden (*talun*) indicates that it is an important habitat and supported for bird protection. Mixed-garden (*talun*) consists of various vegetation with layered structure and serves as a source of springs with lots of ponds as habitat for Javan kingfisher. MacKinnon et al. (2010) mention that Javan Kingfisher widespread in Java and Bali up to an altitude of 1.000 m asl (above sea level) and frequently seen in open land close to clean water. This species has been lost from several places that are frequently visited.

The other dominant bird species found in previous studies but not found in this study were Crescent-chested Babbler at mixed-garden (*talun*) (Erawan et al. 1997) and Western Yellow Wagtail in cash-crop garden (Husodo 2006). Crescent-chested Babbler is a shy bird that moved in a closed cover and usually found in low-to-high strata in bamboo forest (Erawan et al. 1997). Husodo (2006) noted that only found 2 individuals in the mixed-garden (*talun*) in Sukapura Village. This species is protected according to Law No. 5/1990 about the biodiversity and ecosystem conservation and Ministry of Environment and Forestry Regulation (PermenLHK) No.106/2018. Decreased bamboo-tree garden as Crescent-chested Babbler habitat in Sukapura Village is suspected to be the cause of decline of this bird population.

Table 1. List of bird species and number of individual bird found in mixed-garden (*talun*), homegarden and cash-crop garden in Sukapura and Resmi Tingal Village, Upper Citarum Watershed, West Java, Indonesia

Family	Scientific name	English name	Feeding guild	Mixed-garden (<i>talun</i>)	Home-garden	Cash-crop garden
Accipitridae	<i>Pernis ptilorhyncus</i>	Crested Honey Buzzard	C	1	-	-
Accipitridae	<i>Spizaetus cirrhatus</i>	Crested Hawk-Eagle	C	1	-	-
Alcedinidae	<i>Halcyon cyanoventris</i>	Javan Kingfisher	P	19	-	-
Alcedinidae	<i>Todirhamphus chloris</i>	Collared Kingfisher	P	8	-	-
Apodidae	<i>Apus affinis</i>	House Swift	IN	-	4	-
Columbidae	<i>Streptopelia chinensis</i>	Spotted Dove	F	16	9	8
Cuculidae	<i>Cacomantis merulinus</i>	Plaintive Cuckoo	I	2	5	-
Cuculidae	<i>Cuculus sepulchralis</i>	Rusty-breasted Cuckoo	I	3	-	-
Cuculidae	<i>Cuculus sparverioides</i>	Large Hawk-Cuckoo	I	1	-	-
Dicaeidae	<i>Dicaeum trochileum</i>	Scarlet-headed Flowerpecker	IF	1	2	-
Hirundinidae	<i>Hirundo striolata</i>	Striated Swallow	I	4	26	11
Hirundinidae	<i>Hirundo tahitica</i>	Pacific Swallow	I	2	4	1
Laniidae	<i>Lanius schach</i>	Long-tailed Shrike	I	2	-	1
Muscicapidae	<i>Muscicapa dauurica</i>	Asian Brown Flycatcher	I	2	-	-
Nectariniidae	<i>Anthreptes simplex</i>	Scarlet-headed Flowerpecker	IN	-	5	-
Nectariniidae	<i>Nectarinia jugularis</i>	Olive-backed Sunbird	IN	17	18	4
Picidae	<i>Dendrocopus macei</i>	Fulvous-breasted Woodpecker	I	2	1	-
Picidae	<i>Dendrocopus mollucensis</i>	Sunda Pygmy Woodpecker	I	2	3	-
Ploceidae	<i>Lonchura leucogastroides</i>	Javan Munia	F	78	140	66
Ploceidae	<i>Lonchura punctulata</i>	Scaly-breasted Munia	F	1	6	5
Ploceidae	<i>Passer montanus</i>	Eurasian Tree Sparrow	F	79	261	204
Pycnonotidae	<i>Pycnonotus aurigaster</i>	Sooty-headed Bulbul	IF	1	-	2
Pycnonotidae	<i>Pycnonotus goaiver</i>	Yellow-vented Bulbul	IF	1	-	-
Sylviidae	<i>Cisticola juncidis</i>	Zitting Cisticola	I	-	-	2
Sylviidae	<i>Orthotomus ruficeps</i>	Ashy Tailorbird	I	5	13	5
Sylviidae	<i>Orthotomus sutorius</i>	Common Tailorbird	I	4	10	9
Sylviidae	<i>Orthotomus sepium</i>	Olive-backed Tailorbird	I	9	2	1
Sylviidae	<i>Prinia familiaris</i>	Bar-winged Prinia	I	-	4	1
Sylviidae	<i>Prinia polychroa</i>	Brown Prinia	I	11	-	-

Note: C: Carnivorous; F: Frugivorous; I: Insectivorous; P: Piscivorous; N: Nectarivorous; IF: Insect-frugivorous; IN: Insect-nectarivorous

Table 2. Dominance index values of bird species in three different land-use types

English name	Scientific name	Family	Di	
Mixed-garden (Talun)				
Eurasian Tree Sparrow	<i>Passer montanus</i>	Ploceidae	29.04	D
Javan Munia	<i>Lonchura leucogastroides</i>	Ploceidae	28.68	D
Javan Kingfisher	<i>Halcyon cyanoventris</i>	Alcedinidae	6.99	D
Olive-backed Sunbird	<i>Nectarinia jugularis</i>	Nectariniidae	6.25	D
Sooty-headed Bulbul	<i>Streptopelia chinensis</i>	Columbidae	5.88	D
Homegarden				
Eurasian Tree Sparrow	<i>Passer montanus</i>	Ploceidae	50.88	D
Javan Munia	<i>Lonchura leucogastroides</i>	Ploceidae	27.29	D
Striated Swallow	<i>Hirundo striolata</i>	Hirundinidae	5.07	D
Olive-backed Sunbird	<i>Nectarinia jugularis</i>	Nectariniidae	3.51	SD
Ashy Tailorbird	<i>Orthotomus ruficeps</i>	Sylviidae	2.53	SD
Cash-crop garden				
Eurasian Tree Sparrow	<i>Passer montanus</i>	Ploceidae	64.15	D
Javan Munia	<i>Lonchura leucogastroides</i>	Ploceidae	20.75	D
Striated Swallow	<i>Hirundo striolata</i>	Hirundinidae	3.46	SD
Common Tailorbird	<i>Orthotomus sutorius</i>	Sylviidae	2.83	SD
Sooty-headed Bulbul	<i>Streptopelia chinensis</i>	Columbidae	2.52	SD

Notes: D = Dominant ; SD = Sub-dominant; TD = Non-dominant

Western Yellow Wagtail is a migratory bird that generally passes in the winter in the lowlands, especially in the Great Sunda coast, including the small islands around it. These species usually visit rice fields, swamps, and grasslands, often living in very large groups, foraging around cattle and buffaloes (MacKinnon et al. 2010). This bird was not found in the observations because the observation time did not coincide with the migration period.

Bird Diversity Index (H'), Species Richness Index (Dmg), and Evenness Index (E) in different site

The data in Table 3 shows that in all cases, the birds in the mixed-garden (*talun*) were considerably more diverse than in the homegarden and cash-crop garden. Shannon-wiener diversity index showed that mixed-garden (*talun*) had higher diversity ($H'=2.2$) than homegarden ($H'=1.55$). Cash-crop garden had the lowest bird species diversity ($H' = 1.21$). Species richness index of bird in mixed-garden (*talun*) (Dmg=24.82) was higher than homegarden (Dmg=16.84) and cash-crop garden (Dmg=12.83). The evenness of bird species index (E) in the mixed-garden (*talun*) (E=0.68) was higher than homegarden (0.55) and cash-crop garden (E=0.47).

The high index of diversity and index of species richness in the mixed-garden (*talun*) compared to other sites is estimated by the high number of bird species to be balanced with the level of individual distribution by each species. In addition, this is also closely related to the variety of types of vegetation in the mixed-garden (*talun*) which provides many choices for birds to use resources for various needs of life. This also supports previous research conducted by Erawan et al. (1997) and Husodo (2006) that the mixed-garden (*talun*) is an important habitat for bird species that are outside forest areas due to stratification of layered vegetation resembling forests. Although the area of mixed-garden (*talun*) in the study area was decreased due to the conversion of land (cash-crop gardens), but in some *talun*, vegetation canopy and stratification of layered vegetation can still be found. It's still supported as a good habitat for various bird species.

According to Evenness index category (Krebs 1985), the bird species evenness index in the mixed-garden *talun* was High (E value > 0.6), while the evenness index in the homegarden and cash-crop garden was in the Medium category ($0.4 < \text{value } E \leq 0.6$). This fact revealed that bird species in the mixed-garden (*talun*) are evenly distributed although the number of individuals in one species is small. Evenness index in arranging a community can be determined by the availability of feed resources needed by bird that can be found in certain land-use areas. Husodo (2006) pointed out that the existence of a bird depends on the number of food source species rather than the large variety of available food.

Conservation status, endemic and migrant bird

Two species of Accipitridae (Crested Honey Buzzard and Crested Hawk-Eagle) found only in mixed-garden (*talun*) (Table 4). There were 3 species classified as 'Endemic bird species' (17.24% of the total species); namely, Javan kingfisher found only in mixed-garden (*talun*), Olive-backed Tailorbird found in all sites and Bar-winged Prinia found in homegarden as well as in cash-crop garden. Migrant bird species found only 1 species (3.45% of the total species), namely Asian Brown Flycatcher. Migrant birds travel from the northern hemisphere to reach areas with warmer temperatures, especially in the equatorial region, one of which is Indonesia. The bird species along with their conservation status, endemic and migrant are presented in Table 4.

Table 3. Bird Diversity Index (H'), Species Richness Index (Dmg), and Evenness Index (E) in different site

Site	Ind.	N	F	H'	Dmg	E
Mixed-garden (<i>Talun</i>)	272	25	14	2,2	24,82	0,68
Homegarden	513	17	13	1,55	16,84	0,55
Cash-crop garden	318	13	7	1,21	12,83	0,47

Note: Ind.: Individual; N: number of species; F: Family; H' : Shannon-wiener diversity index; Dmg: Margalef Richness index; E: Evenness index;

Table 4. List of protected bird species, endemic and migrant in study site

English name	Scientific name	PermenLHK No.106/2018	CITES	IUCN	Endemic	Migrant
Crested Honey Buzzard	<i>Pernis ptilorhynchus</i>	P	Ap.II	LC		
Crested Hawk-Eagle	<i>Spizaetus cirrhatus</i>	P	Ap.II	LC		
Javan Kingfisher	<i>Halcyon cyanoventris</i>	Unp	-	LC	J,B	
Collared Kingfisher	<i>Todirhamphus chloris</i>	Unp	-	LC		
Asian Brown Flycatcher	<i>Muscicapa dauurica</i>	Unp	-	LC		√
Scarlet-headed Flowerpecker	<i>Anthreptes simplex</i>	Unp	-	LC		
Olive-backed Sunbird	<i>Nectarinia jugularis</i>	Unp	-	LC		
Olive-backed Tailorbird	<i>Orthotomus sepium</i>	Unp	-	LC	J,B,L	
Bar-winged Prinia	<i>Prinia familiaris</i>	Unp	-	LC	S,J,B	

Note: Protection status: P: Protected; Unp: Unprotected; Ap.II: Appendix II CITES; LC: Least Concern, S: Sumatera; K: Kalimantan; J: Java; B: Bali; L: Lombok

The birds from the Accipitridae are also included in CITES appendix II. According to Iskandar (1980) and Husodo (2006) that a bird species is categorized as a protected species not solely because rarely population or endangered but also because of its function/role in an important ecosystem. Birds from Accipitridae families have an important function in ecosystem, as a top predator which makes it a counterweight to the ecosystem. More abundant raptor species indicate the abundance of food availability like small mammals.

The protected bird species from Accipitridae and Alcedinidae families can only be found in the mixed-garden (*talun*). This fact shows that the mixed-garden (*talun*) has an important role in the species of the two families. Soemarwoto and Soemarwoto (1984) and Parikesit et al. (2005) explained that one of the functions of traditional agroforestry (*talun*) is as a place for germplasm conservation, one of which is as a habitat for birds.

In conclusion, that species diversity of birds differs among the land-use types. Mixed-garden (*talun*) has the highest bird species diversity, species richness index and evenness index, while cash-crop garden has the lowest diversity, richness and evenness index. There was a significant decrease in some bird species which in the previous study was dominant to be reduced even to local extinction. This was allegedly caused by the conversion of mixed-garden (*talun*) into cash-crop gardens and housing. In addition, unregulated bird hunting is also one of the causes of the decline in bird populations, specifically birds with market value. Our study implicates that preserving mixed-garden (*talun*) patches in a landscape dominated by cash-crop garden is one of the strategies to conserve bird diversity. Moreover, educate local people about bird significance to the environment and involve them to raise awareness should be considered in bird conservation strategy in rural areas.

ACKNOWLEDGEMENTS

This study is part of the Academic Leadership Grant (ALG) program of Prof. Oekan S. Abdoellah, funded by DIPA Universitas Padjadjaran, Indonesia fiscal year 2017. Therefore, the authors thank Universitas Padjadjaran that has provided ALG program as implementation to achieve World Class University. The authors would like to thank Khair Bunayya from Ornithology Division, Himbio Unpad for the great contribution to bird data collection. In addition, we would like to thank the head of the village of both Sukapura and Resmi Tingal Villages and his staff, along with the informants who have kindly helped us to provide information during the process of this research. We also would like to thank Efan Ekananda for proofreading and editing this paper.

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