Birds

In a Coffee Agroforestry Landscape in Lampung

Trudy O'Connor, Subekti Rahayu and Meine van Noordwijk

World Agroforestry Centre

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Multistrata coffee (page 14): Kurniatun Hairiah
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Foreword

“Birds in a Coffee Agroforestry Landscape in Lampung” started as a scientific object of study for a PhD thesis. In Central America there has been a lot of attention paid to coffee gardens and their role in providing habitat for migrant and resident birds. Coffee certified as being shade grown gets a better price. We wondered if there are similar effects of shaded versus open coffee gardens to be found in Indonesia. Would there also be opportunities for 'rewards for environmental services' where farmers who maintain bird habitat can get a better price?

Here is some of what we found. We hope that you enjoy the pictures showing some of the differences and similarities between the birds that were found in the different habitats, and that you get some understanding of the choices farmers make.

The field work on which this booklet is based was carried out in Sumber Jaya and Krui, both in West Lampung, in Sumatra. Both are locations where a long term research involvement by the World Agroforestry Centre (ICRAF) and its various partners has been carried out to understand the consequences of farmers' decisions to maintain or modify trees and mixed gardens (agroforests) in the landscape. These choices have financial consequences, affecting both the size and reliability of farmers' incomes. The consequences are also social, as they influence the access to land, income and local environmental goods, such as the provision of clean water. Furthermore, these decisions influence the environmental services that are appreciated by wider audiences: they affect downstream communities by influencing water flows, and affect the biodiversity that is enjoyed by everyone. The current focus is on the latter, taking birds both as indicators of other aspects of biodiversity and as a group that generates a lot of interest in its own right. To the farmers, the birds provide 'hiburan' (enjoyment), as they like to see or hear birds when they work in their gardens. They also play many other important ecological roles, such as pollination and seed dispersal. However, as in most parts of the world, many of the farmer choices have a negative effect on bird habitat or populations. This booklet explores these choices and how we might arrive at a good compromise, for farmers, for conservationists and for birds.

Introduction

Birds are losing their forests, especially in the tropics. The main reason that forests are cut down and converted to other land use is that agriculture or industrial tree crops provide more immediate income and labour opportunities than forest. Further, the number of people who look to agriculture to provide their income is increasing. With the loss of the forest, many species of plants and animals are under threat. However, some can adapt to the change and continue to thrive in the gardens that farmers make. So, not all the 'forest functions' are necessarily lost when forests are converted; much depends on how the land is managed subsequently.

Birds are a group of animals that are relatively well known and possible to identify in the wild. They play significant roles in the natural ecosystem and can also provide many benefits in the agro-ecosystems that replace natural forests. The species play different roles, so it is important to maintain many types. Many people who we interviewed in Lampung said that birds provide natural beauty and make them happy. Others also said that birds pollinate flowers and disperse seeds, improve soil fertility or generally contribute to sustainability. The benefit most commonly mentioned was that of pest control.

However, while we have no direct information on how bird populations have changed in the area, the community indicated that they have observed this occurring. In fact 79% of people interviewed said that bird populations have reduced, while 71% also said that the bird species present have changed.

It seems likely that the main reasons for this change are the loss of forest as habitat and the increase in trapping in the area. For many forest birds, the habitat that replaces the forest is not suitable as there is no food available, no place and material for making a nest, no place to hide, or no perches from which they can hunt. While local people are aware of this, they usually believe that the birds can find somewhere else to live. However, forest conversion occurs across Lampung, across Sumatra and across Indonesia -- so where will the birds go? Some of the bird species in these areas do not occur elsewhere on the world (they are 'endemic' to Sumatra), and if their forest habitat is lost on Sumatra, they will have nowhere to go: they will be extinct lost forever. Meanwhile, some other types of birds benefit from the conversion, as they are well adapted to half-open or open habitat. These species will occur in greater numbers. However, to conservationists, this does not 'compensate' for the loss of forest birds, as the birds of half-open and open habitat tend to be already common and widespread.

With this background, we want to illustrate what birds can be found in different types of habitat in the coffee landscapes of Lampung. We hope this can stimulate measures to better protect the forest birds, while still providing income opportunities for the farmers. Agroforestry, where coffee is grown under an upper canopy of fruit or timber trees is one of the choices. Some birds like it, as we will show on the following pages, but for some others, forest is really their only home.

How are coffee gardens managed in Sumberjaya?

Coffee originates from a forest environment in Africa where it grows under the canopy of dominant trees. Logically, when coffee was domesticated and planted in different parts of the world, it was first planted under the shade of other trees. It did well; it rapidly spread across the tropics wherever rainfall, temperature, elevation and soils matched with the original source areas. Farmers gradually learned that while coffee does not have to be grown inside the forest, shading the bushes with trees has important benefits such as: (a) protection of coffee plants against too much sun. In full sunlight coffee exhausts itself by producing very quickly. In the shade, production is more gradual but it will last longer, so that overall the bush may produce more coffee; (b) positive influence on the flavour of coffee, probably linked to the slower ripening of berries and more aromatic compounds; (c) reduced weed pressure, as most weeds are less shade tolerant than coffee itself; higher rate of leaf litter fall leading to (d) better protection of the topsoil and (e) formation of soil organic matter and/or enrichment with nitrogen if there are leguminous trees that obtain nitrogen from the air and make it available in the soil to other plants, (f) provision of a 'microclimate' (local temperature and humidity) similar to that of the forest, reducing pressure of disease and insect attacks (g) fruit trees offer more variety in the farmers' (and their children's) diet and economic base and (h) provide wood for construction.

In the mountainous Sumberjaya area of Lampung, on the island of Sumatra, one can see different types of coffee garden side by side, managed in different ways by the farmers. Some of them grow coffee as part of a 'multistrata' garden, with many other types of trees. Others grow coffee under a lighter shade of mostly leguminous, 'nitrogen fixing' trees. Yet other farmers grow coffee as a monoculture without shade: 'sun coffee'. This diversity of situations allowed us to make direct comparison of the economic and social reasons for farmers to choose a certain management style for their coffee, and also to see the ecological consequences. We also know that management styles change over time and that trees can both be added to an existing garden, or tree cover can be removed to allow more light at ground level. With the international price of coffee always rising or falling, farmers are always trying to adjust their management, sometimes concentrating on coffee and, at other times, planting other crops. Secondly, the management choice depends on the degree of security of tenure. Where farmers perceive a high chance of being evicted from the land, as has happened several times Sumberjaya, they choose the short term gains of 'sun coffee'. However, where they have secure tenure, they generally prefer the shaded or multistrata forms, which we consider to be forms of 'agroforestry'.

There are several species of coffee, with different requirements for climate, different tolerance to diseases, and different quality of products. The arabica coffee (that originates from Ethiopia) is considered to have the best quality, but robusta coffee can produce a higher volume, is more tolerant of diseases and grows at lower elevation. Selection of varieties in the past decades has increased the productivity of 'sun coffee'. Extensionists promoted these systems, along with 'clean weeding' of the gardens that proved to be disastrous for the soil.

Tradeoff between short and long term benefits in agroforestry coffee

The choice for any management style has costs and benefits. In fact there are 'tradeoffs' between the different effects and in making a final choice of garden type, the farmer needs to weigh up many consequences. The research results summarized in Table 1, together with farmers' knowledge suggests that agroforestry coffee has conservation benefits for watershed functions, soil fertility, biodiversity and carbon stocks when compared with monoculture or sun coffee systems. If ecological benefits coincide with economic benefits, why would any farmer choose monoculture?

Some farmers' preference for open coffee is linked to insecurity of tenure, especially where the farmers are 'squatters' on state forest lands. Their opportunities and risks have varied along with the overall political climate and the strength of the forestry department in enforcing its regulations. If negotiations can lead to agreements that provide long term land use rights, we can expect farmers to plant more trees and reap the long term benefits from the multistrata coffee garden system. The evidence in Sumberjaya has shown that this is indeed what farmers do. Unfortunately, the various layers of government sometimes disagree over the rules that can be used, and so farmers face considerable uncertainty driving them back to simpler garden systems with short term benefits.

In the Krui area on the coast of West Lampung a further development has occurred in the 'multistrata' coffee gardens. The resin ('damar') producing Dipterocarp tree *(Shorea javanica)* was 'domesticated' in these gardens a century ago, when the forest sources became depleted and the price for this product was high. In these gardens, during the first years, food crops provide the main income, followed by a phase during which coffee dominates. This is like the current stage of development in Sumberjaya gardens. Some twenty years after a garden is planted, the damar trees become the main source of income and they can last 40-50 years, depending on the intensity of tapping. As these damar systems often develop from a coffee garden, we include them here in the comparison. Although damar trees may not be suited to Sumberjaya, the gardens in Krui give one example of how a multistrata garden might look if cared for over several generations.

Table 1. Ecological and financial conditions in the different types of coffee garden in Sumberjaya area, compared with remnant forest

Parameter	Monoculture coffee	Multistrata coffee	Forest
Ecology:			
a. Watershed function:			
• Erosion	High (37.2 ton/ha in a 3 year old coffee)[1]		Low (0.3 ton/ha)
• Infiltration rate	Low (1.4 cm/hour)		High (11 cm/hour)
• Macropores in the soil (v/v)	Low (3.6%)	Low (3%)	High (12.2%)
b. Soil fertility			
• Litter layer	Low (1.2 ton/ha)	Medium (1.8 ton/ha)	High (2.1 ton/ha)
• Soil organic matter relative to baseline C_{org}/C_{ref}[2]	0.36	0.33	0.71
c. Aboveground carbon stock	Low (7.2 ton/ha)	Medium (33 ton/ha)	High (196 ton/ha)
d. Biodiversity			
• Earthworm biomass	12 g/m^2	18 g/m^2	31 g/m^2
• Abundant of insect-predator ant	0 individuals/3 m^2	0.6 individuals/ 3 m^2	19 individuals/3 m^2
Economic:			
• Benefit (NPV[3] at current local market price, 25 year assessment period)	Rp. 24,000 /ha	Rp.7,500,000 - 33,500,000/ha[4]	
• Return to labour	Rp. 6,176 / day	Rp. 8,016 - Rp. 13,924 / day	
• Internal rate of returns (IRR)[5]	4.9%	21.4 - 32.2%	
• Productivity period	12-15 years	25-30 years	
• External input (fertilizer, pesticides, labour)	High	Low	
• Pest pressure	Medium	Low	

[1]Erosion affected by the land management as well as the soil characteristics that vary within the catchment
[2]C_{org}/C_{ref} is an indicator of soil fertility, the value of 1 indicate the fertility of undisturbed soils
[3]Difference between income at the current value and cost at that time
[4]This value is the benefit of agroforestry coffee with a commercial understorey crop (upland rice and chilli) until the third year after planting
[5]IRR is an indicator whether the investment will give a benefit or not.

Sources: Erosion and infiltration rate (Widianto et al, 2004); macropores, litter, carbon stock and earthworm biomass (Hairiah et al, 2004); abundant of insect-predator ant (Susilo dan Hazairin, 2006); benefit, return to labor, IRR (Budidarsono and Wijaya, 2004); productivity period (SIPPO, 2004); external inputs (Kimani et al, 2002; Budidarsono and Wijaya, 2004); coffee pests (Setiawan, 2005).

Can agroforestry coffee be used in conservation areas?

It is no surprise that many environmental aspects of shade or multistrata coffee are better than monoculture. However, it is less certain if this type of coffee agroforestry can provide enough protection for the rest of the watershed? Can it play a worthwhile role in biodiversity conservation?

Watershed functions

Protective forest ('hutan lindung') is expected to provide downstream areas with a regular flow of qood quality water, and protect it from floods, landslides and mudflows. People's perspectives on silt loads in rivers have changed with time; previously they were seen as a source of fertility for ricefields, now they are seen as a problem as they fills up reservoirs. Can the trees in agroforestry coffee help in securing or recovering these functions? Trees will:

a. Change the way in which rainfall reaches the ground. A substantial portion of rainfall that strikes the vegetation is intercepted by the tree canopy and evaporates from there, never touching the ground. In Sumberjaya this may be up to 20% of rainfall for forest and 15% for multistrata coffee. Some water flows along branches and stems. Other drips from the leaves, and could cause erosion if it weren't for the under storey vegetation that soften the impact on the soil. Finally the litter layer protects the soil from splash impact and supports the earthworms and other organisms that create soil spaces allowing rapid infiltration of water. A good multistrata garden can provide these functions nearly as well as a natural forest, and better than a monoculture tree plantation ('reforestation').

b. Help to provide clean water. If the soil is saturated due to previous rainfall and flows overland, the litter layer acts as a filter and ensures that little soil particles are not carried away in the water.

c. Improve the cohesiveness (holding together) of the soil through root systems that 'anchor' the deeper layers and help to hold the topsoil together in a 'mat'. These two effects combined reduce the risk of landslides. However, if the soil layer is deep and consequently heavy (especially when saturated with water), and there are lines of weakness in the subsoil (again especially when water makes the soil more 'fluid'), landslides will nevertheless occur. Depending on the type and number of trees, these functions will be provided in coffee agroforestry at a level intermediate to a natural forest and a sun coffee

garden. After disturbance of the forest it will take some time before the roots of forest trees decompose and lose their anchoring function. It will certainly take time before the newly planted trees have roots large enough to fulfil this anchoring role again. In the period between, the risk of landslides is probably increased. However, if landslides don't occur in this early-middle period, the later situation is likely to be safer in a more mature multistrata coffee garden.

Biodiversity

Forests in Sumatra are home to many migratory and resident birds, reptiles, ants, butterflies, plants and other organisms, that is, 'biodiversity'. Forest conversion drastically changes this biodiversity, but the change depends on the habitat created. Agroforestry gardens can provide a structure that is somewhat forest-like. A tall and diverse structure of the vegetation in agroforestry coffee is one step towards supporting a wide array of organisms; each species can find its niche among the several layers of vegetation and the variety of food sources available. A wide variety of tree types in the canopy also makes it more likely that a garden can support high biodiversity. Thus, agroforestry coffee may partly help substitute for the loss of tropical forest and provide a rest area for birds.

In the following pages we describe the different birds found in the habitat types in Sumberjaya. Overall, we can distinguish two effects: the structure of vegetation, and the intensity of human use, linked to its character as a 'natural' or 'agricultural' landcover. In Figure 1 we have arranged the observations by habitat such that the four 'natural' systems on the right represent a gradient from grassland via scrub to forest (short and simple, to tall and complex). Next to forest we put the most forest-like form of agroforestry, the damar gardens of Krui. Moving further to the left, we have progressively more open agricultural land uses (returning from tall and complex to short and simple). The series ends on the left with the paddy rice fields. As very open habitats, these mirror the grasslands on the extreme right of the figure. Clearly the number of birds seen in the standardized survey method is not a good indication of the biodiversity: the rice fields have the highest numbers but most of these are specialized in eating rice. In the figure we therefore present the relative proportions of birds observed in each habitat.

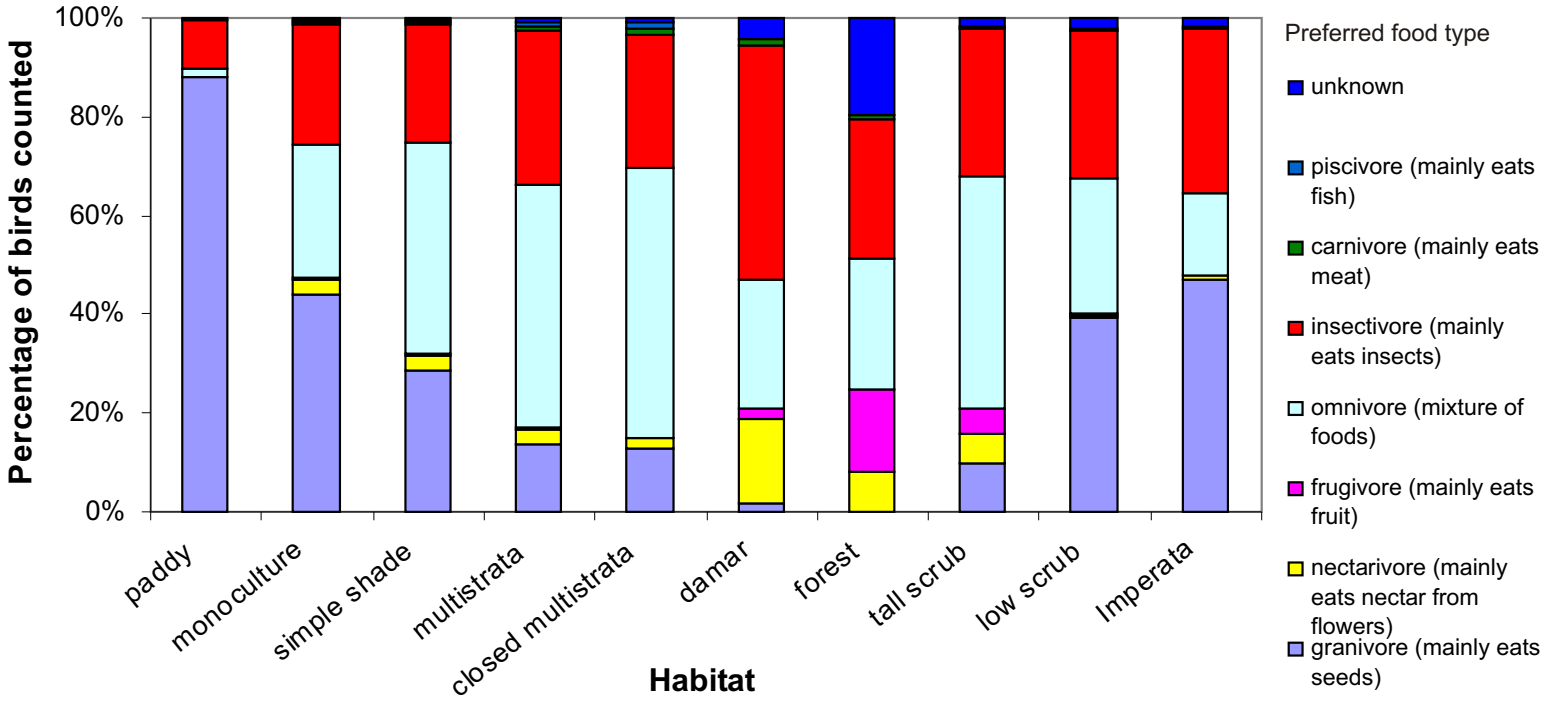

Figure 1. Relative proportion of food source (as can generally be derived from the shape of the bill) of the birds seen in the survey in different land use types Sumberjaya and Krui

Compared with monoculture coffee, agroforestry coffee (multistrata and shaded coffee) supports a higher diversity, but not higher numbers of birds. The seed eaters that dominate in the more open habitats become a smaller component in the more shaded habitats and the omnivores take over as the main group. Insectivores become relatively more important. Moving further towards the forest, the diversity of feeding guilds increases, with nectarivores and frugivores increasing. Nectarivores (nectar eaters) were seen most in the damar gardens and secondary forest ('tall scrub'), whilst frugivores (fruit eaters) occur mainly in the natural habitats of forest and tall scrub, where there are enough fruit-bearing trees.

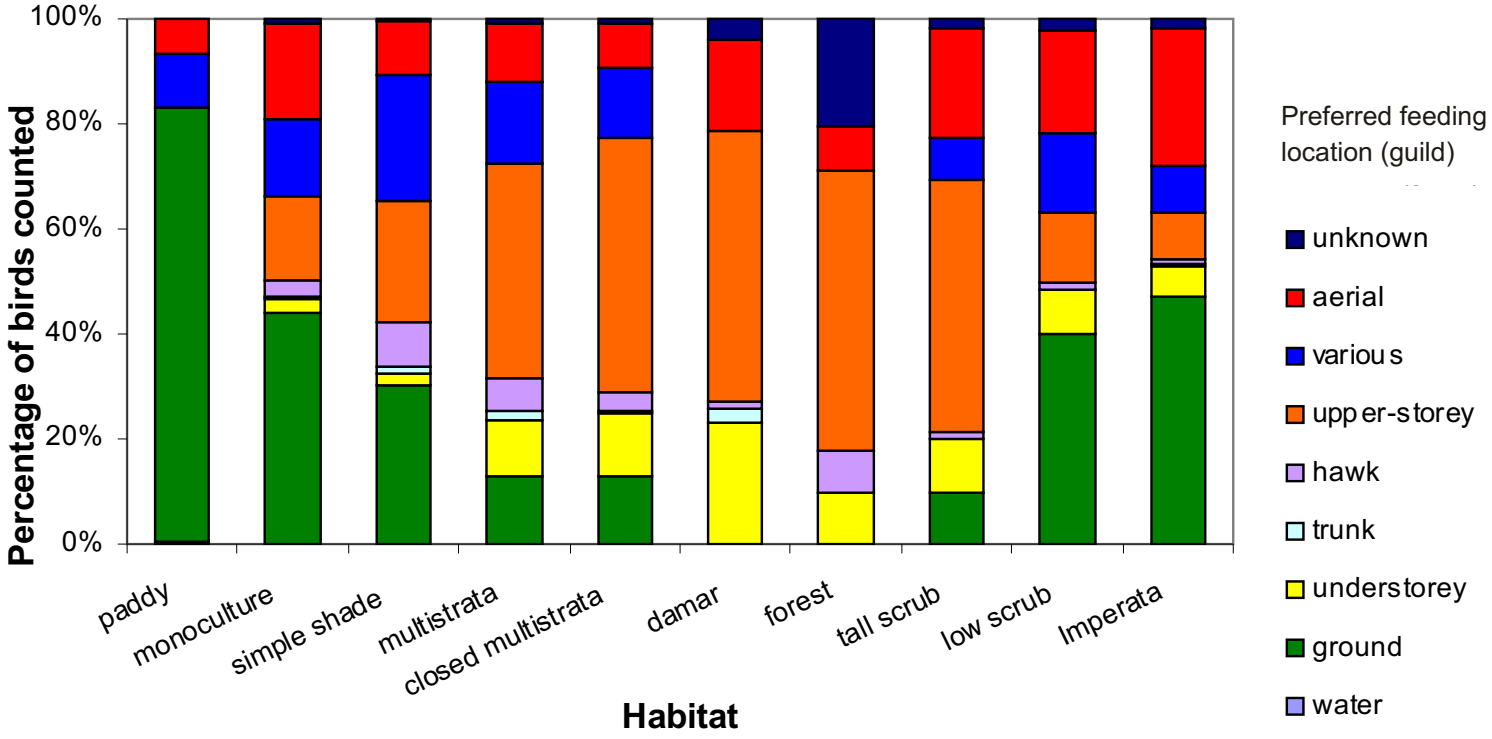

Figure 2. Relative proportion of preferred feeding location (guilds) of the birds observed in the several types of land use in Sumberjaya and Krui.

The surveyed birds can also be defined by their preferred feeding location ('guild'), as shown in Figure 2. There obviously are more ground feeders in paddy than in all other habitats, although all of the open habitats contained more of these than did the complex habitat types. In contrast, the more complex habitats such as multistrata coffee, damar, forest and tall scrub had more under storey birds and upper-storey birds, usually using trees present at these sites (Figure 2). We will describe these results for each habitat type in the following pages, starting with the forest, which is the original habitat in the region.

Figure 3. Birds in forest

Birds in forest

The rainforests that are native to Sumatra are very tall, have complex structures, including many layers, and also have many species of trees and under storey plants. This provides suitable places for many bird species to live, and the birds are well adapted to the cool, dark and moist environment. However, if the structure is simplified, for example by removing tree layers, or if important vegetation species are lost, the landscape becomes unsuitable for many of the native birds. As high quality forests are now becoming rare in Sumatra, it is these forest-dependent birds that are particularly important for conservation.

Birds that eat fruit are common in the rainforest. These include hornbills, barbets, leafbirds and fruit-eating pigeons. These birds are less common in other habitats, perhaps for the simple reason that the trees that provide fruit suitable for them to eat are not available. Other birds that are more common in the forest include babblers, which often like a dense under storey with lots of leaf litter on the ground, where they can find insects.

Some of the birds found in the forest in the region are found nowhere in the world outside of Sumatra island. They are 'endemics', and it is especially important to conserve these birds locally, or they will become completely extinct. One of these birds is the Blue-masked leafbird *(Chloropsis venusta)*.

Figure 4. Birds in 'damar' garden

Birds in 'damar' garden

The damar gardens, from which 'damar' resin of Shorea javanica trees is harvested is an agroforest, a type of agricultural habitat containing many trees useful to the community, and managed by them. However, the bird biodiversity found in these gardens is rather high compared with other farming systems. Some of the birds found in the damar agroforests are similar to those of the forest, like sunbirds, flowerpecker, minivet and babblers. In the damar gardens one can also find bulbuls, eagles, doves, cuckoos and fork-tailed swifts. However, there are also many forest species that are missing.

It seems that while there is no real substitute for 'real' forest, the damar gardens are able to provide many types of birds with a place to live, build nests, hide from predators and find food of various types. It does this because the vegetation is complex, with many types of trees that are allowed to grow for many years, and in a way that is not too simplified or regulated. In addition to the trees that are planted, many other plants that grow on their own after their seeds have been carried by the wind or by animals, are allowed by the farmers to grow without disturbance, making the garden more like a 'natural forest'. Another factor that may explain why the damar provides good habitat for some forest birds is that there the tree cover is continuous, allowing birds to move a long distance through the canopy without having to cross open spaces.

Figure 5. Birds in the scrub

Birds in the scrub

Where open land has been left for some years, 'scrub' grows. Early on, this has few trees (we call this low scrub), but gradually more types of seeds germinate and taller trees grow. Where there was a dense under storey of shrubs and ferns, birds such as prinias and tailorbirds were found. Sometimes there were also Magpie robins, although it seems likely that many of these had already been trapped and taken away, and so may no longer breed so well in the area.

Many of the birds, such as munias were also adapted to open conditions. Shrubs and trees provided perches for birds such as bulbuls, in particular the Black-headed bulbul, which is very common in Lampung, but also the Yellow-vented bulbul and the Black-crested bulbul.

Whilst the bird species found were usually not forest-adapted, there were still some fruit eaters present where trees provided suitable food. These did not occur in the agricultural habitats studied.

Figure 6. Birds in multistrata coffee

Birds in multistrata coffee

'Multistrata' coffee was the most diverse and complex of the coffee systems we studied. While the under storey was almost entirely coffee, there was a canopy of shade trees that often included legumes, which make nitrogen available in the soil to other plants, timber trees and fruit trees, and so have many other benefits for farmers, in addition to protecting the soil and the coffee plants.

The birds commonly present included the same bulbuls that were in the scrub, Rufous-tailed Tailorbirds, Oriental White-eyes, Asian Brown Flycatchers, Orange-bellied flowerpeckers and Olive-backed Sunbirds. Where there were damar trees with soft wood, there were often Sunda Woodpeckers.

Most birds that were seen using the vegetation were using the trees, rather than using the coffee. However, the trees that were present were usually not native trees, and the canopy was much lower, more simples and less closed than in the forest. It is perhaps for this reason that most of the forest birds were still missing. In particular, there were very few fruit eaters and nectar feeders present.

Figure 7. Birds in simple shade coffee

Birds in simple shade coffee

The gardens we have called 'simple shade' had a canopy of trees over the coffee, but generally only consisting of a few species. Most commonly in Sumberjaya, these were Gliricidia or Erythrina trees, which are both good protectors of the soil and coffee, but do not provide other resources such as fruit.

Many of the birds found in this simple shade coffee were similar to those of the multistrata gardens, but some species were missing, or less common. Instead, there were more birds that are adapted to open areas, such as munias, Sooty-headed and Yellow-vented Bulbuls. Birds needing somewhere to perch, but not needing a very dense canopy were also present, including Plaintive Cuckoos, Zebra Doves, and Spotted doves. Ashy tailorbirds also sheltered and looked for insects in the coffee bushes.

Figure 8. Birds in monoculture coffee

Birds in monoculture coffee

In 'monoculture' coffee gardens there were very few shade trees. In these gardens, there were many birds flying overhead such as Barn Swallows, as well as many on the ground, such as munias. However, there were fewer birds using the vegetation, than in the multistrata coffee. This was not surprising as there were very few perches and not many types of food available.

In contrast to the forest, most of the birds found in monoculture coffee were adapted to open areas. For example, the Black-headed Bulbul was very common, but other more specialised bulbuls were not present in the monoculture coffee.

Some of the species found in monoculture were the same as those found in multistrata coffee. However, more species were unique to multistrata coffee than were to monoculture coffee.

Figure 9. Birds in Imperata grassland

Birds in Imperata grassland

Birds were also surveyed in grassland that is dominated by Imperata cylindrica (alang alang). This grass is common throughout Southeast Asia and often occurs on very degraded sites where there is frequent fire.

The birds present were often similar to those found in monoculture coffee and rice paddy. In particular, there were many White-headed Munias, as well as Barn Swallows and Glossy Swiftlets flying overhead. There were also some Black-headed Bulbuls and Yellow-vented Bulbuls which used any perches available.

In general, there were few places for birds to perch or feed, but the dense cover was used by birds such as Hill Prinias and Yellow-vented Prinias.

If left for long enough, and there are nearby sources of seeds, the grassland is likely to develop into scrub. Some birds help this regeneration process by carrying seeds from other scrubland or forest.

Figure 10. Birds in rice paddy

Birds in rice paddy

Birds were surveyed in wet rice paddies that were located in the valley floors. These paddy areas are very important for food production throughout much of southeast Asia, but are not very suitable for many forest-adapted animal species.

While there were many individual birds seen in the paddies, most of these were from only a few species. These birds were usually grain eaters such as the Java Munia, White-headed munia and Scaly-breasted Munia, as well as the Eurasian Sparrow. Many rice farmers put a great deal of effort into scaring these birds so that their crops are not ruined. The White-breasted Waterhen and Cinnamon Bittern are species that are adapted to wetland conditions. Natural wetlands are now rare due to their replacement by paddy fields.

As there were few perches available, many birds were observed flying overhead or sitting on the ground. These conditions are very different from those in forest, as the birds not only have few perches, but also few places to hide and not many types of food.

Economic and social benefits

Economic, rather than ecological aspects are often the main drivers of farmers' decisions regarding land management. However, over the long term, the two are more closely related than they might at first seem. So, in addition to the ecological benefit to community if farmers choose to plant agroforestry-style (multistrata), rather than monoculture coffee, the farmers also receive extra economic benefits.

Research in the Sumberjaya area shows that a multistrata coffee garden can give a farmer more benefit than monoculture coffee because of:

- Low external input (fertilizer, pesticides, labour). Budidarsono and Wijaya (2004) reported that the total amount of fertilizer (Urea and TSP) in multistrata coffee is 256 kg/ha/year, without pesticide and the total amount of labour is 32 WDP[6]/ha/year. In contrast, the monoculture systems need Urea, TSP dan KCl fertilizer in quantities of amount is 1 ton/ha/year, in addition to pesticide and fungicide, while the amount of labour required is 86 WDP/ha/year.

- Additional income. In the agroforestry coffee with fruit and timber trees, farmers can harvest fruits such as banana, guava, cloves, jackfruit, rambutan, pete, mango and durian, in quantities of around 4.5 ton/ha/year, also timber (2.4 m^3/ha/year), bamboo (37 clumps/ha/year) and palm sugar (65 liter/ha/year). Of course the produce depends on what trees the farmer decides to incorporate in the garden. In the monoculture coffee, the only other produce harvested by farmers is upland rice that is usually grown until the third year after the garden establishment (Budidarsono and Wijaya, 2004).

The low external input (saving time and money) and the additional producys yielded from agroforestry coffee are direct benefits which can be received by farmers. The greater security of income provided by diversifying the garden products is another benefit, as it allows farmers to plan for the future. This means that their families are more likely to be able to afford health care and education. Maintaining the health of the garden environments, including their soils and the animals that control pests will allow these children to inherit gardens that are still productive and profitable. More indirect benefits shared by the community include the conservation of watershed functions. The downstream communities can then receive sufficient clean water, air, and, potentially, electricity (if a hydroelectric scheme is established).electricity.

[6] Work Day Person

Conclusion

Agroforestry coffee with fruit trees, nitrogen-fixing trees and timber trees as a systems which have ecological, economic and social benefits. Ecological benefits of the agroforestry coffee such as maintenance of watershed functions, soil fertility, biodiversity and carbon stocks result in economic and social benefits for farmers such as better diets, more secure livelihoods, clean air and water.

The choices made in managing the land have important consequences not only for the farmers, but also for the birds that live there. It seems that no other land use in Sumberjaya can provide conditions to support the same species as forest. As there is very little forest remaining in Lampung it seems very important to take care of the patches that remain if their birds and other inhabitants are to survive. No coffee garden seems able to support the truly forest-adapted birds.

The coffee farms in Sumberjaya do not currently fit the requirements for existing programs for certification of shade-grown coffee, because the tree diversity is too low, fertilizer and pesticide use too high and product quality is too low. However, there may still be ways in which the community could help to improve conditions for birds in the area.

One way of protecting the forest may be to provide a 'buffer' around it. This buffer could be composed of coffee gardens. If a continuous canopy of trees were planted around the forest edge, this may help preserve the special conditions of shade and humidity within the forest itself. If suitable species were to be planted, these trees may also provide some food and shelter for birds adapted to the forest edge.

Secure tenure systems such as those provided through the community forest management agreements (HKM) that are currently being negotiated may be one way by which this buffer could be encouraged, since insecure tenure usually leads to short-term farming systems, rather than agroforestry.

As the birds in damar agroforests are much more similar to those of the forest, this provides a good example of how the landscape might look in the long term. This could most likely be developed from multistrata gardens, like the gardens of Krui once were. However, to achieve this would require co-operation of the community, to create a rather closed canopy and greater acceptance of native plant and tree species in the gardens. Some of these plants may germinate on their own, especially if there are birds and other animals to transport the seeds. Many of them could have uses in addition to providing shade for coffee. Indeed, the damar gardens of Krui provide the community with many resources, including fruit, vegetables, timber and medicines. Although coffee is no longer productive there, the people have allowed a complex system to develop that provides security and important resources that are valuable to the community as well as to the birds who live there.

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The birds shown in the various habitats

No.	Picture	Local Name	Size (cm)	Scientific name	Family	Habitat
1.		Cinnamon bittern	37	*Ixobrychus cinnamomeus*	Ardeidae	Paddy field
2.		Changeable hawk-eagle	70	*Spizaetus cirrhatus*	Accipitridae	Damar
3.		Black eagle	70	*Ictinaetus malayensis*	Accipitridae	Multistrata, simple shade coffee, forest, scrub
4.		Chinese goshawk	33	*Accipter soloensis*	Accipitridae	Simple shade coffee
5.		Crested Goshawk	40	*Accipter trivirgatus*	Accipitridae	Simple shade coffee
6.		Black-thighed falconet	15	*Microhierax fringillarius*	Falconidae	Multistrata coffee
7.		Blue breasted Quail	15	*Coturnix chinensis*	Phasianidae	Multistrata, monoculture coffee
8.		White-breasted waterhen	33	*Amaurornis phoenicurus*	Rallidae	Paddy field
9.		Emerald dove	25	*Chalcophaps indica*	Columbidae	Damar
10.		Mountain Imperial Pigeon	45	*Ducula badia*	Columbidae	
11.		Zebra dove	21	*Geopelia striata*	Columbidae	Multistrata, monoculture coffee, scrub
12.		Spotted dove	30	*Streptopelia chinensis*	Columbidae	Paddy field, simple shade

No.	Picture	Local Name	Size (cm)	Scientific name	Family	Habitat
13.		Little Cuckoo dove	30	*Macropygia ruficeps*	Columbidae	Damar
14.		Barred cuckoo dove	38	*Macropygia unchall*	Columbidae	Damar
15.		Lesser Coucal	42	*Centropus bengalensis*	Cuculidae	Monoculture, multistrata coffee, imperata grassland
16.		Greater Coucal	52	*Centropus sinensis*	Cuculidae	Simple shade coffee
17.		Drongo cuckoo	23	*Surniculus lugubris*	Cuculidae	Closed multistrata coffee
18.		Plaintive cuckoo	21	*Cacomantis merulinus*	Cuculidae	Monoculture, multistrata, simple shade coffee, damar
19.		Rusty-breasted cuckoo	23	*Cacomantis sepulchralis*	Cuculidae	Multistrata coffee
20.		Fork-tailed swift	18	*Apus pacificus*	Apodidae	Paddy field, multistrata, monoculture coffee, damar
21.		Little swift	15	*Apus affinus*	Apodidae	Multistrata coffee, low scrub
22.		Silver-rumped Swift	11	*Rhapidura leucopygialis*	Apodidae	Multistrata, monoculture coffee, damar
23.		Glossy swiftlet	10	*Collocalia esculenta*	Apodidae	Paddy field, imperata, monoculture, simple shade multistrata, scrub, forest
24.		Black-backed Kingfisher	14	*Ceyx erithacus*	Alcedinidae	Forest
25.		White-throated kingfisher	25	*Halcyon smyrnensis*	Alcedinidae	Scrub, multistrata, simple shade, monoculture coffee, imperata

No.	Picture	Local Name	Size (cm)	Scientific name	Family	Habitat
26.		Collared kingfisher	24	*Todirhamphus chloris*	Alcedinidae	Multistrata, simple shade, monoculture coffee
27.		Blue-throated bee-eater	28	*Merops viridis*	Meropidae	Forest
28.		Great Hornbill	125	*Buceros bicornis*	Bucerotidae	Forest
29.		Brown barbet	17	*Calorhamphus fuliginosus*	Capitonidae	Forest and damar
30.		Black-browed barbet	20	*Megalaima oortii*	Capitonidae	Multistrata coffee, forest
31.		Gold-whiskered barbet	30	*Megalaima chrysopogon*	Capitonidae	Forest, scrub
32.		Coppersmith barbet	15	*Megalaima haemacephala*	Capitonidae	Scrub, multistrata, simple shade coffee
33.		Sunda woodpecker	12	*Picoides moluccensis*	Picidae	Scrub, multistrata, simple shade, monoculture coffee, imperata
34.		Rufous piculet	10	*Sasia abnormis*	Picidae	Monoculture coffee, damar
35.		Green Broadbill	18	*Calyptomena viridis*	Eurylaimidae	Forest
36.		Black-and - yellow broadbill	15	*Eurylaimus ochromalus*	Eurylaimidae	Damar
37.		Barn swallow	20	*Hirundo rustica*	Hirundinidae	Forest, scrub, multistrata, simple shade, monoculture coffee, , paddy field, imperata
38.		Asian house-martin	13	*Delichon dasypus*	Hirundinidae	Multistrata, monoculture coffee

No.	Picture	Local Name	Size (cm)	Scientific name	Family	Habitat
39.		Common pipit	18	*Anthus novaseelandiae*	Motacillidae	Paddy field, simple shade coffee Scrub,
40.		Grey wagtail	18	*Motacilla cinerea*	Motacillidae	Multistrata, simple shade, monoculture coffee, paddy field, imperata
41.		Forest wagtail	17	*Dendronanthus indicus*	Motacillidae	Simple shade coffee
42.		Bar-winged flycatcher-shrike	15	*Hemipus picatus*	Campephagidae	Damar, kopi multistrata
43.		Pied triller	18	*Lalage Nigra*	Campephagidae	Multistrata cofffe, damar
44.		Lesser cuckoo-shrike	20	*Coracina fimbriata*	Campephagidae	Multistrata coffee
45.		Scarlet minivet	19	*Pericrotus flammeus*	Campephagidae	Forest and damar
46.		Fiery minivet	15	*Pericrotus igneus*	Campephagidae	Forest and damar
47.		Streaked Bulbul	22	*Ixos malaccensis*	Pycnonotidae	Forest
48.		Ashy bulbul	20	*Hypsipetes flavala*	Pycnonotidae	Forest
49.		Blackcrested bulbul	18	*Pycnonotus melanicterus*	Pycnonotidae	Forest, damar, scrub, multistrata, monoculture coffee, imperata
50.		Black-headed bulbul	17	*Pycnonotus atriceps*	Pycnonotidae	Forest, damar, multistrata, simple shade, monoculture coffee
51.		Sooty-headed bulbul	20	*Pycnonotus aurigaster*	Pycnonotidae	Scrub, multistrata, simple shade, monoculture coffee, paddy field

No.	Picture	Local Name	Size (cm)	Scientific name	Family	Habitat
52.		Grey-cheeked bulbul	22	*Alophoixus bres*	Pycnonotidae	Forest
53.		Yellow-vented bulbul	20	*Pycnonotus goiavier*	Pycnonotidae	Scrub, multistrata, simple shade, monoculture coffee,imperata
54.		Blue-masked leafbird	14	*Chloropsis venusta*	Chloropseidae	Forest
55.		Green iora	13	*Aegithina viridissima*	Chloropseidae	Damar
56.		Long-tailed shrike	25	*Lanius schach*	Laniidae	Scrub, multistrata, monoculture, simple shade coffee, imperata
57.		Tiger shrike	19	*Lanius tigrinus*	Laniidae	Multistrata coffee
58.		Rufous-tailed Shama	21	*Trichixos pyrrhopygus*	Turdidae	Forest
59.		Magpie robin	20	*Copsychus saularis*	Turdidae	Scrub, multistrata, simple shade coffee
60.		Rusty-breasted wren babbler	18	*Napothera rufipectus*	Timaliidae	Damar
61.		White-browed shrike-babbler	13	*Pteruthius flaviscapis*	Timaliidae	Forest
62.		Striped tit-babbler	13	*Macronous gularis*	Timaliidae	Mulristrata coffee, damar
63.		Ferruginous babbler	17	*Trichastoma bicolour*	Timaliidae	
64.		Black-capped babbler	17	*Pellorneum capistratum*	Timaliidae	Damar
65.		Spot-necked Babbler	17	*Stachyris striolata*	Timaliidae	Forest
66.		Arctic warbler	12	*Phylloscopus borealis*	Sylviidae	Forest, scrub, multistrata, simple shade coffee
67.		Ashy tailorbird	12	*Orthotomus ruficeps*	Sylviidae	Damar, scrub, multistrata, monoculture, simple shade coffee

No.	Picture	Local Name	Size (cm)	Scientific name	Family	Habitat
68.		Rufous-tailed tailorbird	11	*Orthotomus sericeus*	Sylviidae	Multistrata coffee, damar
69.		Lanceolated warbler	12	*Locustella lanceolata*	Sylviidae	Imperata
70.		Hill prinia	16	*Prinia atrogularis*	Sylviidae	Monoculture coffee, scrub, imperata
71.		Bar-winged prinia	13	*Prinia familiaris*	Sylviidae	Multistrata, monoculture coffee, imperata
72.		Yellow-bellied prinia	13	*Prinia flaviventris*	Sylviidae	Srcub, monoculture coffee, imperata
73.		Asian brown flycatcher	14	*Muscicapa dauurica*	Muscicapidae	Scrub, multistrata, monoculture, simple shade coffee
74.		Yellow-rumped flycatcher	13	*Ficedula zanthopygia*	Muscicapidae	Multistrata, simple shade coffee
75.		Verditer flycatcher	16	*Eumyias thalassina*	Muscicapidae	Multistrata, simple shade coffee
76.		Indigo flycatcher	14	*Eumyias indigo*	Muscicapidae	Damar
77.		Fulvous-chested Jungle flycatcher	15	*Rhinomyias olivacea*	Muscicapidae	Forest
78.		Black-naped monarch	14	*Hypothymis azurea*	Monarchidae	Damar
79.		Velvet-fronted nuthach	12	*Sitta frontalis*	Sittidae	Damar
80.		Scarlet-headed flowerpecker	8	*Dicaeum trochileum*	Dicaeidae	Forest, imperata grassland
81.		Orange bellied flowerpecker	8	*Dicaeum trigonostigma*	Dicaeidae	Forest, damar, scrub, multistrata, simple shade, monoculture, imperata
82.		Scarlet-backed flowerpecker	9	*Dicaeum cruentatum*	Dicaeidae	Multistrata, monoculture, scrub

No.	Picture	Local Name	Size (cm)	Scientific name	Family	Habitat
83.		Fire-breasted flowerpecker	9	*Dicaeum ignipectus*	Dicaeidae	Monoculture coffee
84.		Plain flowerpecker	8	*Dicaeum concolor*	Dicaeidae	Multistrata coffee, damar
85.		Yellow vented Flowerpecker	9	*Dicaeum chrysorrheum*	Dicaeidae	Forest
86.		Crimson-breasted flowerpecker	10	*Prionochilus percussus*	Dicaeidae	Monoculture, damar
87.		Yellow-breasted flowerpecker	13	*Prionochilus maculatus*	Dicaeidae	Forest, damar
88.		Temminck's Sunbird	13 (male) 10 (female)	*Aethopyga temminckii*	Nectariniidae	Forest
89.		Ruby throated Sunbird	14	*Anthreptes singalensis*	Nectariniidae	Multistrata coffee
90.		Plain sunbird	12	*Anthreptes simplex*	Nectariniidae	Monoculture coffee, damar, forest
91.		Purple-naped sunbird	15	*Hypogramma hypogrammicum*	Nectariniidae	Damar
92.		Olive-backed sunbird	10	*Nectarinia jugularis*	Nectariniidae	Scrub, multistrata, simple shade, monoculture coffee,imperata
93.		Little spiderhunter	15	*Arachnothera longirostra*	Nectariniidae	Monoculture coffee, damar, forest, tall scrub
94.		Oriental white-eye lowland form	11	*Zosterops palpebrosus*	Zosteropideae	Damar, scrub, multistrata, monoculture, simple shade, coffee, imperata
95.		Black-capped white-eye	11	*Zosterops atricapilla*	Zosteropideae	Multistrata coffee
96.		White-headed munia	11	*Lonchura maja*	Ploceidae	Scrub, multistrata, simple shade, monoculture coffee, paddy field, imperata

No.	Picture	Local Name	Size (cm)	Scientific name	Family	Habitat
97.		Pin tailed parrotfinch	15	*Erythrura prasina*	Ploceidae	Multistrata, simple shade, monoculture coffee, paddy field,
98.		Javan munia	11	*Lonchura leucogastroides*	Ploceidae	Scrub, multistrata, simple shade, monoculture coffee, paddy field, imperata
99.		Scaly breasted munia	11	*Lonchura punctulata*	Ploceidae	Scrub, multistrata, simple shade, monoculture coffee, paddy field, imperata
100.		Eurasian tree sparrow	15	*Passer montanus*	Ploceidae	Multistrata, monoculture coffee, paddy field
101.		Javan myna	25	*Acridotheres javanicus*	Sturnidae	Monoculture, multistrata coffee
102.		Black-naped oriole	26	*Oriolus chinensis*	Oriolidae	Monoculture coffee
103.		White-breasted wood-swallow	18	*Artamus leucorynchus*	Arta Midae	Paddy field, monoculture, multistrata coffee, scrub

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