

The ecological, economical and social benefit of Dukuh in South Kalimantan

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The ecological, economical and social benefit of Dukuh in South Kalimantan

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Abstract. This study aims to reveal the ecological, economic dan social benefits of the Dukuh agroforestry system. The ecological data were collected using the survey method and interview. There were 16 quadrant plots measuring 20 m x 20 m placed in 4 selected Dukuh. The sampling method used was nested sampling. Fauna and characteristic of land were carried out using the exploration method by following the vegetation measurement plot. Data on socio economic benefits were obtained from interviews about the income, cost, ethnobotany, and social data. Some supporting data needed to be obtained from village office documents and literature references. The ecological data were analyzed by using species composition and diversity index. Species composition was analyzed by tabulation matrices. The species diversity index was calculated using the Shannon-Wiener Index. Economic benefits are assessed from the economic contribution of Dukuh. Ethnobotanical and social benefit data were analyzed descriptively. There are 38 species of trees and 14 species of understorey found in Dukuh. Shanon index value for tree and understorey of Dukuh species are > 2 (medium category). The ecological characters of Dukuh help retain soil aggregates, increase infiltration, reduce erosion and facilitate preference habitat for animal life. Some animals belong to the category of protected fauna (*Manis javanica*, *Varanus borneensis*, *Harliantus indus*). Aves diversity index value is $H' = 2.54$ (middle category). Dukuh is also a habitat for 13 species of soil fauna. The economic benefits are identified from: The dukuh's harvest contributes 30% of the farmers' total income; Some Dukuh plants are useful as emergency income and medicinal plants. The social benefit of Dukuh is increasing friendship between the community and improving the family's social status. This information provides an overview of how successful local community forest farming is in providing benefits to the environment.

1. Introduction

Indonesia's forest gardens form a traditional land use in the area adjacent to the forest. The garden is characterized as vegetation by the close character of the vegetation of natural forests. Forest gardens in Indonesia have been proven their importance to the South Kalimantan community's economy, especially around forests [1]. One form of a forest garden in South Kalimantan is the family garden known as Dukuh.

The status of Dukuh was originally a family garden inherited from one generation to another generation with limited management for subsistence needs in South Kalimantan. The community



agroforestry system has been formed in relatively long stages as a result of a combination of natural processes and community trial-error efforts in meeting their living needs and responding to the bio-ecological conditions of the surrounding environment [2]. The existence of Dukuh in line with the development of time has changed as a means of production and services with ecological, economic, and social values that have strategic value [3].

Dukuh is dominated by fruit species planted in irregular cropping patterns, unstructured planted, non-uniform age strata located within settlements, and ex-community of traditional rice fields. Dukuh, in the perspective of agroforestry, is included in the form of multipurpose forest tree production systems, namely the management system of various wood species, which is produced not only for wood products but also for leaves and fruits, human food, or animal feed.

Forest gardens by Dukuh species can ecologically support the environment, such as preventing erosion, reducing flood hazards, improving hydrological systems. Successful dukuh garden seasonally improves villages income and help them to generate into business.

The existence of Dukuh as a forest farming practice by Banjar people must be preserved. Determining the value of ecological, economic, and social benefits is part of the effort to maintain the existence of Dukuh. This study aims to reveal the ecological, economic, and social benefits of the Dukuh agroforestry system.

2. Method

2.1. Study area

This research was conducted in Mandiangin Barat Village, Karang Intan District, Banjar Regency, South Kalimantan Province. The area covered about 5.64 km² administratively in Karang Intan Topography District, Banjar Regency, South Kalimantan, with an area of 215.65 km² located at a position of 20°49'55" – 30°43'38" latitude and 114°30'20"-115°35'37" east. The research was carried out for three months which included research preparation, field orientation, determination of research locations, data processing, and preparation of research reports.

2.2. Materials and methods

The materials of research were Dukuh species. Benefit value analysis was carried out by identifying the value of the ecological, social, and economic benefits of the Dukuh vegetation species. Data collection on the ecological, social, and economic benefits of Dukuh was obtained from farmers who were selected as informants.

The tools that will be used are:

- Tools for interviewing informants. Some of the tools used in the interview used were: Camera for documentation, Questionary for collecting ecological, social, and economic parameters data
- Tools for measuring vegetation. Some of the tools used to measure vegetation include Phiband for measuring the diameter of trees, laser tape for measuring tree height.
- Tools for a survey of fauna. Some of the tools used in fauna survey include: binoculars for fauna observation, a manual book for identification of mammals, reptilia, and aves.

2.3. Data collection

The data collection procedure is carried out as follows:

- Semi-structured interview

Informants were selected proportionally from community members who reside in Dukuh in West Mandiangin Village. The total number of informants was 30 persons. The sample size used was 10% of the total population residing in Dukuh. Some of the selected informants include village headmen, community leaders, and Dukuh owners. The data collected is data on ecological, economic, and social benefits. The data were collected by using semi-structured interviews. The questions were asked openly by referring to the list of questions in the questionnaire. Reference data is needed to support the

completeness of research data. Some supporting data needed to be obtained from village data documents and related research results.

- Vegetation measurement

The sample of Dukuh that was measured was 4 Dukuh which were selected purposively. Each selected Dukuh will be measured, made 4 (four) plots measuring (20 m×20 m) or equivalent to a size of 40 m ×20 m. Vegetation data collection used nested sampling [4]. The 20 m × 20 m quadrats were used to record trees with DBH (Diameter at Breast Height) ≥ 20 cm. Poles, defined as trees with DBH 10- 19.9 cm, were enumerated in a 10 m x 10 m plot nested in the quadrats. Saplings, defined as trees with height > 1.5 m and DBH < 10 cm, were enumerated in 5 m × 5 m plots nested in the 10 m x 10 m plots. Seedlings (defined as woody plants with more than two leaves and height of < 1.5 m) and other understorey species were sampled with 2 m × 2 m plots nested in the 5 m × 5 m plots. The vegetation parameters measured were the number of individuals and species identity.

- Fauna observation

Observations of fauna were carried out using the exploration method by following the vegetation measurement plot. Fauna measurements were carried out mainly for mammals, reptilia, and birds. Direct observation was carried out through the identification of animal tracks and animal sounds. In addition to direct observation, data were collected based on the information provided by the informants. Additional data were also collected from research results.

- Land observation

Observations of the land dan microclimate of Dukuh were carried out using the exploration method. Observation plots were made following the vegetation measurement plots. Additional data were also collected from Government Statistics Institution (Badan Pusat Statistik) Banjar District, and research results.

- Socio-economic data collection

Data on economic benefits were obtained from interviews about the gross income from the sale of the Dukuh fruit species, the cost in the management of Dukuh. Information about income outside the Dukuh was also collected. Its data were used to calculate the contribution of the Dukuh to the community's income. Another economic benefit data is the ethnobotany aspect of Dukuh species for the community. Data on social benefits were obtained from interviews with the social benefits of the Dukuh. Additional data were also collected from research results.

2.4. Data analysis

- Ecological benefits

Data processing on ecological benefits is carried out by calculating the composition of tree vegetation types based on habitus and fauna species above ground and below ground surface. Ecological benefits can be indicated from the composition of vegetation species and the vegetation diversity index of Dukuh. Species composition of vegetation was analyzed by tabulation matrices. The species diversity index was calculated using the Shannon-Wiener Index with the following equation (1) [5].

$$H' = - (\sum p_i \ln p_i) \quad (1)$$

Where:

H' : Species Diversity Index

p_i : n_i/N

N_i : number of individuals of the 1st species

N : Number of individuals of all types

Diversity level criteria: H' < 1 = low; 1 < H' < 3 = medium; H' > 3 = high

The identification of other ecological benefits was analyzed from the characteristics of the land and microclimate. Land characteristics and microclimate data were obtained from field observations and reference data from the Central Statistics Agency (BPS) of Banjar District.

Ecological benefits were described from the analysis of the role of the Dukuh as a habitat for animals. Fauna data were analyzed descriptively based on the results of direct observations, data from informants, and research results.

- Economic and Social benefit

Economic benefits are assessed from the economic contribution of Dukuh to the local community. The contribution of Dukuh management to community income was carried out using the following equation (2).

$$C = \frac{II}{II+EI} \times 100\% \tag{2}$$

Where:

C : Economic contribution from Dukuh (%)

II : Income from Dukuh management

EI : Income from outside Dukuh management business

Social benefits are identified as either social benefits as individuals or in social relationships between community members. Ethnobotanical and social benefit data were analyzed descriptively.

3. Result and discussion

3.1. The ecological benefits of Dukuh

3.1.1. Dukuh as a contributor to diversity for trees, regeneration, and understory in an ecosystem.

Ecological benefits can be indicated from the composition of tree vegetation species, and the regeneration of Dukuh is 38 species. The results of the growth of the tree and regenerative plot are listed in the following table 1.

A group of trees dominated by fruit tree species with irregular cropping patterns, non-uniform strata, and stands of the same age as a Dukuh. The Dukuh stands to resemble a natural forest, also known as forest gardens, orchards, fruit islands. The results of field observations found that there were at least three main species of fruit trees that occupied the Dukuh, namely the Durian (*Durio zibethinus*), Langsat (*Lansium domesticum*), and Cempedak (*Artocarpus champeden*) species (figure 1). There are five species of vegetation that are always present at each stage of growth. *Hevea brasiliensis*, apart from being planted in monoculture, is often found growing mixed in the Dukuh vegetation community. The diversity (H') value for the vegetation level of seedlings, saplings, poles, and trees is 2.45, 2.25, 2.41, and 2.30. This diversity value is included in the medium category.

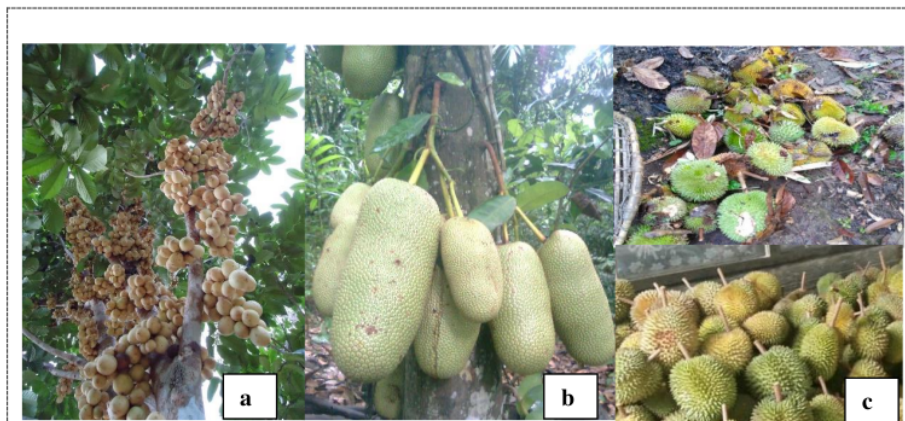


Figure 1. Tree main species of Dukuh (a. *L.domesticum*, b. *A.champeden*, c. *D.zibethinus*).

Table 1. Growth information of Dukuh species in Mandiangin Village.

Dukuh species	Local name	Growth level			
		seedling	sapling	Pole	tree
<i>Aglaia sp</i>	Jawaling kijang	+	-	-	-
<i>Artocarpus champeden*</i>	Cempedak	+	+	+	+
<i>Artocarpus altilis</i>	Sukun	-	+	+	+
<i>Artocarpus heterophyllus</i>	Nangka	+	-	+	-
<i>Artocarpus sp</i>	Nangkaan	+	-	-	-
<i>Bacaurea macrocarpa</i>	Kayu kapul	+	-	-	-
<i>Baccaurea motleyana</i>	Rambai	-	+	+	+
<i>Bouea macrophylla</i>	Ramania	-	+	+	+
<i>Citrus maxima Merr.</i>	Jeruk bali	-	+	+	-
<i>Coffea sp</i>	Kopi	-	-	+	-
<i>Dracontomelon mangiterum</i>	Singkuang	+	-	-	-
<i>Durio zibethinus*</i>	Durian	+	+	+	+
<i>Garcinia mangostana</i>	Manggis	-	+	+	+
<i>Gnetum gnemon</i>	Melinjo	-	+	-	+
<i>Henteara elata</i>	Kilayu	+	-	-	-
<i>Hevea braziliensis*</i>	Karet	+	+	+	+
<i>Lansium domesticum*</i>	Langsat	+	+	+	+
<i>Mangifera indica</i>	Mangga	-	-	-	+
Dukuh species	Local name	Growth level			
		seedling	sapling	Pole	tree
<i>Manilkara kauki</i>	Sawo	+	+	+	+
<i>Nephellium lappaceum*</i>	Rambutan	+	+	+	+
<i>Parkia speciosa</i>	Petai	-	+	+	+
<i>Peronema canescens</i>	Sungkai	-	+	+	-
<i>Pithecollobium jiringa*</i>	Jaring	+	+	+	+
<i>Sandoricum koetjapa</i>	Kecapi	+	+	+	+
<i>Syzygium aromaticum</i>	Cengkeh	-	+	+	-
<i>Syzygium malaccensis</i>	Jambu bol	-	+	+	-
<i>Tamarindus indica</i>	Asam Jawa	-	-	+	-
<i>Tristanopsis sp</i>	Juwaling	+	-	-	-
<i>Uncaria gambir</i>	Gambir	-	-	-	+
<i>Uruphyllum arborescens</i>	Patindis	+	-	-	-

Information: + = presence; - = absence; *= species present at each growth

In addition to the presence of trees and regeneration, some understorey was also found growing in Dukuh. The composition and Shanon diversity index of understorey species found in the Dukuh community is presented in the following table 2.

Table 2. H' result of Dukuh understorey species.

No	Species composition	H'
1	<i>Elingera sp</i>	0.367
2	Family Graminae	0.296
3	Rubiaceae	0.228
4	<i>Calamus axillaris</i>	0.205
5	<i>Dioscorea composita</i>	0.179
6	<i>Lygodium scandens</i>	0.137
7	Zingiberales sp	0.112
8	<i>Salacca zalacca</i>	0.084
9	<i>Ananas comosus</i>	0.084
10	<i>Piper ningrium</i>	0.084
11	<i>Caladium sp</i>	0.067
12	<i>Asparagua sp</i>	0.067
13	<i>Pandanus sp</i>	0.049
14	<i>Pogonatherum sp</i>	0.028
		1.987

There are 14 species of the understorey in the Dukuh. *Elingera sp.* is the most commonly found species. The existence of tree species and understorey indicates the ecological role of the Dukuh vegetation on other ecological components in a plant community. The value of the Shanon diversity index (H') > 2 indicates the role of Dukuh as a contributor to the moderate category of diversity in a forest ecosystem.

3.1.2. The role of the Dukuh in soil conservation. Soil types that dominate Karang Intan District are red-yellow podzolic and latosol and alluvial soil types for riverside areas. The parent material of the soil comes from igneous and metamorphic rocks. The landscape form of West Mandiangin Village is generally categorized as wavy and hilly with a slope notation of 15% to 25%, flat to wavy with a height of 49-55 m asl. Based on the classification of Schmidt and Ferguson, including climate type B with an average annual rainfall ranging from 2000 mm to 3000 mm per year. The maximum average air temperature is 33.750C and a minimum average of 22.030C with a maximum average humidity of 99.42% and a minimum average of 56%. In contrast, the daily average evaporation in the rainy season is 3.4 mm, and in the dry season, 3.8 mm. Percentage of the duration of solar radiation on average maximum 60.00% and minimum average 32.00% [1].

The existence of trees and the rejuvenation of understorey that form a variety of canopy stratification has many benefits for the environment, especially in soil development, including being able to help keep soil aggregates from being easily separated and eroded by rainwater and surface runoff [6]. The soil's infiltration capacity also increases with the contribution of litter and the zoning of roots which varies considerably from each growth stage [7].

3.1.3. *Dukuh as a wildlife habitat.* Several mammals were recorded in Dukuh. Some of these mammals include: *Hylobates albibarbis*, *Trachypithecus cristatus*, *Macaca fascicularis*, *Macaca nemestrina*, *Paradoxurus hermaphroditus*, *Sus barbatus*, *Manis javanica*. Protected reptilia such as *Varanus borneensis* can also be found in the Dukuh community. At certain times Sun bears (*Helarctos malayanus*) can also forage in Dukuh. There were 14 species of birds are most often found in Dukuh. *Harliantus indus* uses *D.zibethinus* trees as nesting sites. Aves diversity index value is $H' = 2.54$ (middle category).

Dukuh is also a habitat for 13 species of the order Lepidoptera, of which the family Satyridae contributes 34% of all species. Soil fauna abundance in Dukuh gardens ranged from 60.8-124.8 individuals/m². The number of species found was 7-14 taxon. The dominant soil fauna found were isoptera (27%), isopods (12.2%), and hymenoptera (27.8%). Measuring soil abundance using the abundance pit trap method found the number of individuals ranging from 101-1549. The number of taxon species found was 14-10 taxon. The dominant soil fauna was collembola (94.5%) and hymnoptera (1.2%). Colembola fauna species is known as one of the components that help the reshuffle of organic matter in the mineralization process. Collembola plays an active role in regulating the C/N ratio in the soil. Soil microfauna plays an active role in regulating the improvement of soil properties [8].

3.2. *The Economic benefits of Dukuh*

Some of the economic benefits of Dukuh are as follows:

- Dukuh as a source of annual income for the community
Products from Dukuh (especially fruits from trees species) use are partly sold for cash income and partly consumed in the household. According to the information from the local community, almost all products from Dukuh are regularly sold, a small portion for own consumption in the household. If the production from dukuh is surplus, the owners occasionally sell these products and have some extra cash income.
The income from the traditional Dukuh agroforestry management by the respondents varies in amount, ranging from Rp. 3825000 to Rp. 8200000/year. The dukuh's harvest contributes 30% of the total income of the farmers.
This phenomenon shows a great contribution to increasing farmers' income. For this reason, the social acceptance of the Dukuh agroforestry system is in the high category. The variables of income, production yields, and ease of marketing significantly affect social acceptance [6].
- Trees from dukuh as a source of emergency income.
Emergency in-come occurs when the Dukuh owners have an urgent need. They choose unproductive old trees to cut down, and then the wood can be sold as emergency income
- Dukuh as a source of medicinal plants
Some Dukuh plants are useful as medicinal plants. *Durio zibethinus* fruit skin can be used as a natural pesticide and mosquito repellent. The fruit skin and bark are also used as antifertility agents. The leaves of *Artocarpus champeden* are used by the community as sunscreen. The skin of the *Lansium domesticum* fruit is also used by the community as sunscreen. The bark is used as a medicine for diarrhea.

3.3. *The social benefits of Dukuh*

Some of the social benefits of Dukuh are indicated from:

- The increasing friendship between the community
Social benefits are indicated from the process of exchanging fruit during harvest between people in villager. The value resulting from fruit sales will increase the opportunity to hold community thanksgiving events (in local terminology= BA ARUH).
- Improving the social status of family
The ownership of Dukuh is a special pride for the local community. Dukuh can become social prestige in the village community. Dukuh improves the family's social status. Social benefits are also identified from a high level of social acceptance [3].

3.4. Traditional rubber garden as a source of extra income

According to local community information, there are three species as the main cash crops: *Durio zibhetinus*, *Lansium domesticum*, and *Artocarpus champeden*. Cash crops from 3 species are a regular annual source of income. The village community earns daily income from traditional rubber plantations, coffee plantations, chicken farms, fish farms, etc.

Traditional rubber plantation is also needed by the community. The rubber planting system consists of 2 cropping patterns, namely monoculture or heteroculture mixed with hamlet vegetation. The daily income of rubber helps in the income of farmers to support the seasonal income from Dukuh. The development of other businesses from resources in rural areas is important as a variety of businesses that support the lives of local communities.

4. Conclusion

The ecological benefits value is described by Dukuh as a contributor to diversity for trees, regeneration, and understorey in an ecosystem. There are 38 species of trees and 14 species of understorey found in Dukuh. Shanon index value for tree and understorey of Dukuh species are > 2 (medium category); Dukuh is a preferred habitat for several mammals, reptilia and birds. Some mammals, reptilia, and aves are found living in Dukuh. Some of them belong to the category of protected fauna (*Manis javanica*, *Varanus borneensis*, *Harliantus indus*). Aves diversity index value is $H' = 2.54$ (middle category). Dukuh is also a habitat for 13 species of soil fauna. Soil microfauna plays an active role in regulating the improvement of soil properties. Stratification of the canopy, litter contribution, and root zone of the Dukuh vegetation helps retain soil aggregates, increase infiltration and reduce erosion. The economic benefits are identified from Dukuh as a source of annual income for the community. The dukuh's harvest contributes 30% of the total income of the farmers; The unproductive old trees can be sold as emergency income; Dukuh as a source of medicinal plants. Some plants are useful as medicinal plants for the local community. Furthermore, the social benefit of Dukuh is indicated from the increasing friendship between the community by exchanging fruit during harvest time; The ownership of Dukuh improves the family's social status. This information provides an overview of how successful local community forest farming is in providing benefits to the environment. Business diversity that provides daily income is important in supporting the results of Dukuh, whose income is seasonal. The approach can be done by continuing to develop various business units in the village or by increasing the added value of the Dukuh, such as the optimal use of space, land, and resources to create multiple uses in the Dukuh

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