Pol. J. Environ. Stud. Vol. 33, No. 2 (2024), 1203-1213
DOI: *10.15244/pjoes/172040* ONLINE PUBLICATION DATE: 2023-11-24

Original Research

Impacts of Forest Farmers Management on *Lepironia articulata* Retz.: Conservation Based on Utilization of Peat Ecosystem Biodiversity in South Kalimantan

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Received: 1 June 2023
Accepted: 8 September 2023

Abstract

Peat ecosystems have very important ecosystem services and functions, and roles for human life, the flora and fauna. Management of *Lepironia articulata Retz.* become an alternative business carried out by forest farmers in peat ecosystems. This study aims to evaluate the management of *L.articulata* in supporting peat ecosystem conservation. The research conducted in Haur Gading sub-district, South Kalimantan, Indonesia. Data collection carried out through the interview on the stages of *L.articulata* management and socio-economic data on the community. Field survey were done by collecting ecological data from *L.articulata* habitat. Conservation support for peat ecosystems from *L.articulata* management analyzed using 7 variables and 17 indicators. Conservation support for the peat ecosystem from the management of *L.articulata* result is high (90.24%). Conservation support obtained from the indicator values of social benefits, economic benefits, technical aspects of *L.articulata* management stages, and several ecological benefits. The management of *L.articulata* by forest farmers able to reduce illegal logging and forest fires. Revegetation activities by forest farmers on enrichment planting is one option to increase the diversity of vegetation in peat ecosystems and also the form of conservation based on the utilization of the biodiversity of peat ecosystems. It contributes for improving the socio-economic community and the environment.

Keywords: *Lepironia articulata,* conservation, forest farmers, biodiversity, peat ecosystem

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Introduction

Peat ecosystems have very important functions and roles for human life, the flora and fauna that live in them. The peat ecosystem functions as a direct support for life, for example as a source of food, medicinal plants, fresh water fish, and a habitat for a wide variety of living things. The most important economic benefit of having peatlands for local people is as a source of livelihood.

Peat areas in general have been used for various purposes, especially for agricultural land, logging activities, expansion of plantation areas, places to find freshwater fish, development of plantation forests and other land conversions [1]. Peat has the property of having a strong absorption of water as a dissolved substance (hydro-physical). The water binding capacity of very high peat ranges from 4.5-30 times its dry weight, especially in fibric peat, between 4.5-8.5 times in hemic peat and 3-4.5 times its dry weight in sapric peat [2]. Peat as an ecosystem has unique properties, such as low soil pH, subsidence, and flammability when the hydrological system is disrupted [3]. The use of peat land without paying attention to the unique characteristics of the peat itself causes peatland to be degraded [4].

The peat ecosystem known as the world's main carbon store with enormous potential [5]. Tropical peat swamp forests are mostly located in Southeast Asia covering an area of 24.8 million ha [6-7]. This area reaches 60% of the total area of tropical peat forests in the world. These peat swamp forests are scattered in Indonesia, Malaysia, Thailand, Brunei and a small part in the Philippines. Indonesia has peatlands spread across Kalimantan, Sumatra, Papua and Sulawesi [8]. The area of peatlands in Indonesia in 2016 is around 15 million ha spread over the islands of Sumatra (6.4 million ha), Kalimantan (4.8 million ha) and Papua (3.7 million ha) [9]. In 2021, there is a decrease in the total area of peat in Indonesia to 13.43 million ha spread over the islands of Sumatra (5.85 million ha), Kalimantan (4.54 million ha) and Papua (3.01 million ha) [10]. South Kalimantan has an area of 47,717 ha of peat ecosystems. Of the 2.6 million hectares of land burned in 2015, 34% of which was peatland. The resulting carbon emissions from these fires are estimated at 1.75 billion metric tons of CO2 equivalent [11]. Financial loss is as a result of the incident has been estimated at IDR 221 trillion [12]. Forest fires continued to recur in the following year, where the burned land in South Kalimantan in 2018 was 98,637.99 ha, in 2019 covering an area of 137,848.00 ha and in 2020 covering an area of 3,971.00 ha [13].

Peat ecosystem fires in 2015 in South Kalimantan damaged 18,665 ha of peatland [14]. One of the peat ecosystem areas in South Kalimantan that experienced fires in 2015 was the Sungai Utar-Sungai Serapat peat ecosystem [14]. Fires cause peat swamp ecosystems to change the composition of vegetation and carbon stores [15]. The area of the Sungai Utar-Sungai Serapat peat ecosystem is 44,956 ha with a peatland area of 15,905 ha or 33% of the peat area in South Kalimantan [14]. Peat ecosystem fires in South Kalimantan also occurred in 2018 covering an area of 2,974.98 ha, in 2019 covering an area of 3,716.95 ha, in 2020 covering an area of 173 ha, and in 2021 covering an area of 2,009.35 ha [16]. The community generally uses the Utar-Sungai Serapat peat ecosystem area as a place to find freshwater fish, collect wood and farm rice fields. The phenomenon that has occurred in the last 10 years is that community businesses in peat ecosystems have begun to decline. The businesses that are still being carried out are fishermen (freshwater fish seekers). The reduction in the debt area and the decreasing quantity of trees due to repeated fires has resulted in reduced logging activities. Agricultural fields have also begun to be abandoned by farmers due to rising water levels or excessive inundation in rice fields for a long time. With high stagnant water, farmers are unable to plant paddy rice.

Climate change as the impact of global warming that affects the production process of paddy rice plants. Paddy fields are excessively flooded for long periods during the rainy season. The decline in production in Indonesia is predicted to reach 90 million tons in 2050 due to climate change [17]. The results of field observations show that the community has begun to divert their business by managing *Lepironia articulata* Retz plants on peatlands. *L. articulata* can develop naturally in peat swamp areas, tidal swamps and river areas that are acid sulfate. *L. articulata* is one of the endemic plants that grows wild naturally in peat areas [18]. The morphology of the *L. articulata* plant is in the form of a cylindrical stem or stem like a pipe that grows elongated with a tapered end, has thin partitions that fill the inside, the septum is compact at the base and the stem is shiny green. The outer part of the base is white and covered with leaves that are shaped like a reddish brown sheath. The tapered tip of the stem then grows into a compound flower that will contain many seeds in the generative phase. The flower of *L. articulata* is a compound flower and is located at the tip of the stem. *L. articulata* are in the form of fibers. *L.articula* grows on acid sulfate soils with inundation heights that can reach 1-2 meters [19].

The community manages *L. articulata* as an effort to address the inability to grow rice as the main source of income. The advantage of the *L. articulata* plant is that it can grow in swamps and does not require a certain season and time [20]. Changes in management patterns in utilizing the biodiversity of peat ecosystems are important to study from various aspects, so that many benefits can be obtained and prevent damage that may occur. Based on the high value of the existence of peat ecosystems, it is important to carry out conservation efforts that can accommodate the ecological, economic and social interests of the community. Conservation efforts made for finding solutions to improve the socio-economic community and still maintain the ecological characteristics of the peat ecosystem. Saving peatland

ecosystems carried out based on a balance between ecological, social and economic values. This study aims to evaluate the management of *L. articulata* by forest farmers in peat ecosystems from a conservation perspective.

Experimental

Physical and Chemical Soil Characteristics

The measurement of peat water and peat soil was measured from 3 types of land cover (secondary forest, *L. articulata* land, and open area which no *L. articulata*). Measurement of the pH of peat water and soil used a pH meter from Hanna Instruments (HI 98107). Measurements were repeated 3 times. The water level is measured in the observation hole by measuring the distance between the peat soil surface and the peat water level.

Research Objects and Locations

The object of ecological research was the *L. articulata* plant and its habitat is peatland. The object of the socio-economic research is the community managing *L. articulata* who live in 5 villages in Haur Gading District, Hulu Sungai Utara Regency, South Kalimantan, Indonesia. Both peatland research location and the *L. articulata* plant show in Fig. 1 and Fig. 2, respectively.

The equipment used was equipment for interviewing the community in the form of a list of questions, stationery and a camera. The list of questions contain the number of family members working in the management of *L. articulata*; the age of the respondents involved in the management of *L. articulata*; gender of the respondent involved in *L. articulata* management, total income from L. articulata management, period of income from *L. articulata* management, equipment and materials used in *L. articulata* management. The equipment used for the terrestrial survey is GPS, camera, pH tools, EC meter, peat drill. The materials used for peat soil analysis in the field are distilled water and H_2O_2 to detect the presence of pyrite in peatlands. Lokasi penelitian di Haur Gading District is located between 20 1' 37"– 2 0 35' 58" South latitude, and 1440 50' 58" – 1150 50' 24" East longitude.

Data collection divided into 2 methods, namely collecting ecological data (soil, water and vegetation) and collecting socio-economic data. Terrestrial surveys for collecting ecological data consist of three types of measurements. Firstly, measuring pH and pyrite of soil and peat water. The pH of peat water and peat soil were measured from 3 types of land cover (secondary forest, *L. articulata* land, and open area which no *L.* placed *articulata*). Measurement of the pH of peat water and soil is measured directly using a pH meter (HI 98107). Identification of pyrite is done by dripping liquid hydrogen peroxide (H_2O_2) on a soil sample. The soil sample is in a container and then dripped with H_2O_2. The resulting droplets of liquid hydrogen peroxide

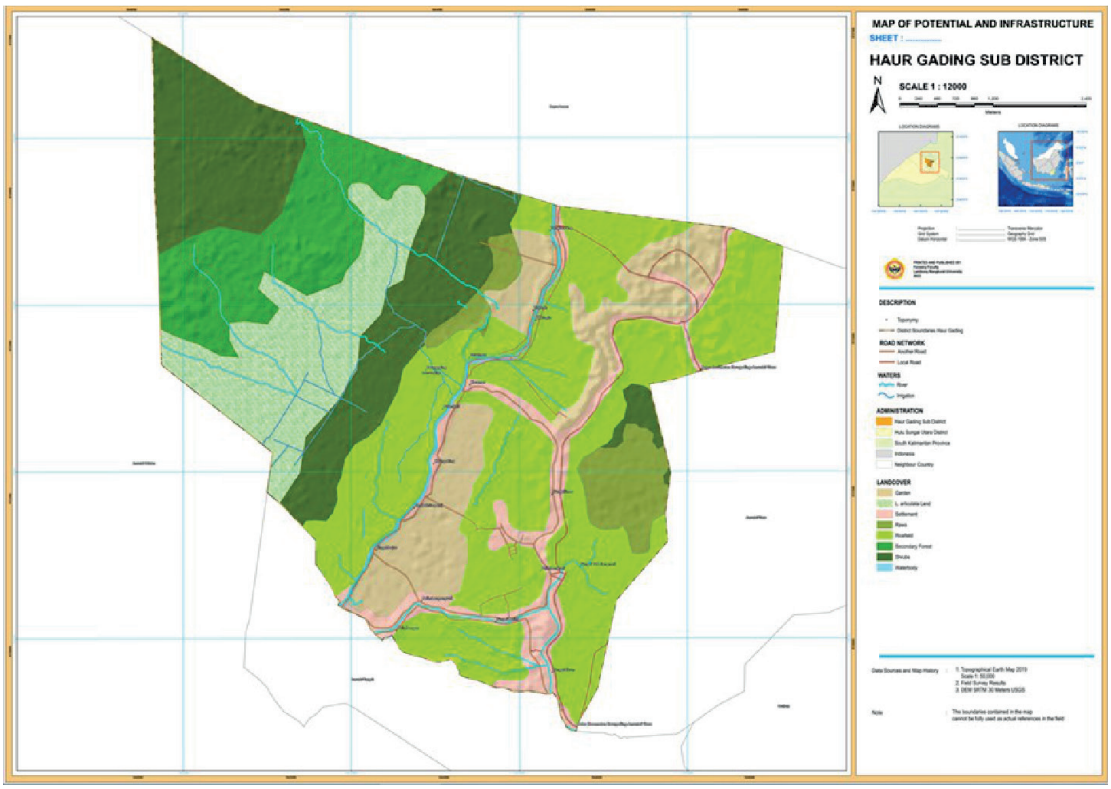

Fig. 1. Research Location at Haur Gading Sub-District South Kalimantan Indonesia.

Fig. 2. Plants of *L.articulata* on peatland.

on the sulfidic material will cause an explosive foam reaction indicating the presence of sulfidic material (pyrite) in a layer of soil [21] pH measurement and pyrite identification were carried out with 3 times of repetition. Secondly, measuring the groundwater level in peatlands. Finally, measuring tree and understorey vegetation, using a measuring plot of 20 m x 20 m for measuring tree level, measuring plot 10 m x 10 m for measuring pole level, measuring plot 5 m x 5 m for measuring sapling level, and measuring plot 2 m x 2 m for measuring seedlings and understoreys. Vegetation measurements were carried out on 3 forms of land cover, namely: secondary forest, purun land and open land. 10 measuring plots were made for each land cover. Placement of measurement plots was done in purposive.

The collection of socio-economic data carried out by interviewing 40 villagers. The interview method used is semi-structured interviews, where questions asked openly while still guided by the list of questions that have been made. The social data collected related to the individual characteristics of the community including age, formal education, non-formal education, length of residence and social status. The economic data collected is in the form of income from purun harvesting and processing of purun crafts. Several socio-economic data collected from village documents and other supporting documents.

Stages of Purun Management by Forest Farmers

The analysis was carried out descriptively by describing the process of land preparation, planting, harvesting, post-harvest processes and woven processing. Management descriptions are presented in a narrative and tabular matrix. Community income data obtained from interviews. The income referred to here is family income [22], which is the total income earned by a family from various activities. The formula approach is as follows:

Family income (IDR/year) = monthly income x 12

The income in question is income from businesses based on the management of *L. articulata* and income from businesses based on non-peat ecosystems. Management of *L. articulata* includes several activities (stages) including land preparation, planting, protection and maintenance, harvesting, post-harvest, and the process of making woven products. Land clearing was the initial activity in the management of *L. articulata*. It was done manually using simple tools. Land clearing activities were executed without burning and were generally carried out in April and May. Next activity after land clearing was planting and was done in June and July. Protection and maintenance of plants during research was to prevent fires. Harvesting was generally done after the plants are ≥6 months and it was by the community in stages up to ±3 months. Post-harvest handling was accomplished by drying and pounding the material. Meanwhile, the process of making handicrafts was performed after the woven material had dried and flattened. The process of making woven was carried out as long as the material is available.

Total Revenue (IDR/year) = *L. articulata* operating income + other income

Revenue contribution (%) = (Revenue from *L. articulata* business/Total Income) x100

Income derived from the management of *L. articulata* includes income from selling raw materials of *L. articulata*, wages from pounding *L. articulata*, and income from selling handicrafts produced from *L. articulata*.

The analytical method used for ecological characteristics consists of parameters of soil, water and vegetation found in peatlands. Analysis of peat soil and water parameters using a tabulation matrix. The analytical method for vegetation parameters is in the form of species composition, and the Shannon's Diversity Index [23]. The formula for determining Shannon's diversity index is as follows:

$$H' = -\sum_{i=1}^{n} \left(\frac{ni}{N}\right) \ln \left(\frac{ni}{N}\right)$$

with:
H' = Diversity Index
N = Total Number of Individuals of all species
ni = Number of Individuals of the i type
In = natural logarithm

The criteria for the parameter of species diversity are classified into several weight criteria and classifications. If the H' value >3 the species diversity is high, if the H' value = 2-3 then it indicates moderate species diversity, and if the H' value <2 the species diversity is low [23].

Management Analysis of *L. articulata* in Supporting Conservation Activities

The variables used for the analysis of *L. articulata* management (description process is listed in Table 1) in conservation are a) Ecological value of *L. articulata* management; b) Social value of *L. articulata* management; c) Economic value of *L. articulata* management; Technical aspects related to the use of materials and tools in planting *L. articulata;* e) Technical aspects related to the use of materials and tools in harvesting *L. articulata*; f) Technical aspects in obtaining raw materials for *L. articulata*; g) Other technical aspects in management *L. articulata* such as land preparation/ land clearing process, maintenance process, post harvesting process, process of screening material quality. A description of the variables and indicators for the analysis of conservation support from the management of *L. articulata* is listed in Table 2. Conservation support is analyzed from the indicator values obtained. The level of conservation support used consists of 3 classes, namely: low, medium and high. The value interval equation for determining the level of conservation used the following equation [24] and spreadsheet software version 2016:

$$\text{Class width} = \frac{\text{(The largest observation value-smallest observation value)}}{\text{(Number of classes)}}$$

Results and Discussion

Description of Purun Plant Management in Peatlands

The *L. articulata* plant (Fig. 2) managed by the community is the result of community planting on open peatlands. Tree felling was not carried out during land preparation for *L. articulata* plantations. The planting location is not directly adjacent to settlements and can be reached by boat.

Land clearing is done manually using a "tajak" (a type of traditional machete for wetlands) to remove grass or water weeds. The planting process is carried out simply by digging a 10 cm x 10 cm x 10 cm hole in peat soil and then planting young purun saplings, then allowing them to grow naturally without special maintenance. *L. articulata* can be harvested when it reaches the age of 6-8 months. *L. articulata* is a group of perennial plants and takes 7 months to reach its maximum weight. The productivity of this plant biomass can reach 8.2 tons per hectare per year [25].

Harvesting done by selecting strands of plant stems that are mature with the characteristics of sturdy stems, green color and no yellowish spots, stems that are not wilted, and hard skin. After a few strands of stem selected and then removed by hand. Old stems, young stems and roots of purun are not harvested. The production process does not require combustion activities [26]. Harvesting by the community 4-5 days a week with a duration of 5-6 hours per day and its workforce dominated by men. *L. articulata* harvesting was not carried out during the peak of the dry month

Table 1. Description of *L.articulata* Plant Management.

No	Management Stages	Activities performed
1	Land preparation/ clearing	Done manually with simple tools Without logging trees and burning land
2	Planting Process	Making planting holes manually with simple tools or just using your hands. No special materials in planting (all materials and tools are environmentally friendly)
3	Maintenance Process	Plants are allowed to develop naturally, peatlands are not drained
4	Harvesting Process	There are no special materials and tools in harvesting (all tools and materials are environmentally friendly) The harvesting process is carried out by removing the selected *L.articulata* stems by hand (all processes do not damage the environment). Only mature stems of *L.articula* were harvested (only a small proportion of biomass was harvested)
5	Post-harvest process	Purun that has been harvested is then dried in the sun or air-dried. Before being processed purun is crushed manually using a wooden pounder (all processes do not damage the environment)
6	The process of making woven products	Some woven products use synthetic dyes (some processes are less environmentally friendly)

Table 2. Variables & indicators for analysis of conservation support from *L.articulata* management.

No	Variables	Indicators
1	Ecological Value of the Existence of *L.articulata*	1. Ability to absorb water from land where *L.articulata* grows: Water level or inundation similar to secondary forest tree vegetation cover = 3, Water level or inundation under secondary forest = 2, Water level or inundation similar to open land without *L.articulata* 2. The value of plant diversity Higher plant diversity index value = 3; Moderate plant diversity index value = 2; Low plant diversity index value = 1 3. Pyrite content There was no pyrite content at all locations of *L.articulata* plants = 3; There is pyrite content in some locations of *L.articulata* plants = 2; there is pyrite content at all locations of *L.articulata* = 1
2	The Social Value of the Existence of *L.articulata*	1. Availability of employment opportunities for the community: >70% of community members work in management of *L.articulata* = 3; 35% - 70% of community members work in managing *L.articulata* = 2; <35% of community members work in *L.articulata* management = 1 2. Traditional skills of the local community Traditional skills mastered by women and men, from the old and young age groups = 3; controlled only by women or only men, from the old and young age groups = 2; dominated by only women or only men, only from the old age group or only young age = 1
3	Economic Value of the Existence of *L.articulata*	1. Revenue contribution from *L.articulata* management The amount of income contribution from management of purun *L.articulata* > 70% = 3; Revenue contribution from purun *L.articulata* management 35% - 70% = 2; Revenue contribution from purun *L.articulata* management <35% = 1 2. Periodicity of Community Economic Income Revenue period is daily-weekly = 3; Monthly income period = 2; Period of seasonal income per 6 months or annually = 1
4	Technical aspects related to the use of materials and tools in planting *L.articulata*	1. Materials used in planting *L.articulata*: All environmentally friendly materials = 3; Some materials are not environmentally friendly = 2; All materials are not environmentally friendly = 1 2. Equipment used in planting *L.articulata* All tools are environmentally friendly = 3; Some tools are not environmentally friendly = 2; All tools are not environmentally friendly = 1
5	Technical aspects related to the use of materials and tools in harvesting *L.articulata*	1. Materials used in harvesting *L.articulata*: All environmentally friendly materials = 3; Some materials are not environmentally friendly = 2; All materials are not environmentally friendly = 1 2. Equipment used in harvesting *L.articulata* All tools are environmentally friendly = 3; Some tools are not environmentally friendly = 2; All tools are not environmentally friendly = 1
6	Technical aspects in obtaining raw materials for *L.articulata*	1. Harvesting process of *L.articulata*: All processes do not damage the environment = 3; Some processes damage the environment = 2; All processes destroy the environment = 1 2. Amount of harvested *L.articulata* biomass Small share of harvested plant biomass (<40%)= 3; 40-60% of harvested plant parts = 2; >60% of the plant part harvested = 1
7	Other Technical Aspects in management	1. Land preparation and clearing process Land preparation without felling trees and without burning land = 3; Land preparation by cutting down some trees and without burning = 2; Land preparation by logging land clearing and/or burning = 1 2. Maintenance Process Plants develop naturally, without making drainage = 3; plants are maintained intensively and without making drainage = 2; plants are maintained intensively and make drainage = 1 3. Post Harvest Process. All processes do not damage the environment = 3; Some processes damage the environment = 2; All processes destroy the environment = 1 4. Product Processing Proces All processes are environmentally friendly = 3; Some processes are less environmentally friendly = 2; All processes are not environmentally friendly = 1

(July-August), because the river water in the peat receded, making it impossible for boats to reach the plant location. Harvesting is also not done during the peak of the rainy season (December-January), because inundation can reach 1.5-2 m above the peat surface. The high inundation made it difficult for farmers to

Fig. 3. The process of drying *L.articulata.*

harvest *L. articulata*. The number of harvest months in a year is ±8 months. The drought factor in the dry season and the overflow of water in the rainy season did not kill the *L. articulata* plant, because this plant is able to adapt to climate fluctuations that occur.

The harvested *L. articulata* tied into several parts and then put into the boat. After arriving at the settlement location, the stems of *L. articulata* were dried in a circular pattern in the sun (Fig. 3). Drying is carried out for ±5 days, until the stems dry with the remaining moisture content ≤10%. The dried stems of *L. articulata* pounded to flatten and soften the hard bark. Crushing done manually using a wooden block or using a crusher. *L. articulata* stems that pounded can be split or not split before being made into plaits. Splitting is done only for certain woven products. Some forms of handicrafts use synthetic dyes and some other forms of handicrafts without dyes. Until now there has been no innovation made by the community in using dyes from natural materials for purun crafts. The average time used in making purun crafts is around 5-7 hours per day. The number of days in the manufacture of woven under normal conditions is 5-6 days/week. Most of the management activities of *L. articulata* are indicated to be environmentally friendly on both aspects, materials and equipment as well as the various management processes carried out. The cultivation of *L. articulata* does not require drainage to regulate water management. *L. articulata* grows naturally without having to dry out the peat soil [26].

Revenue and Revenue Contribution of *L. articulata* Management

The population in Haur Gading District reaches 16,379 people in which as many as 8,040 people are male residents and 8,339 people are female residents. The population density reaches 431.00 people/km. As much as 72.41% of the village community, their main job is as rice farmers. Other than farming, he also works as a daily labourer, catches fish and raises local chickens. The farming pattern adopted by the community is paddy farming in producing rice. Community income categories are divided into 4 categories. The results of the identification of the community's average income/ month are listed in the Table 3.

The income of the dominant community ranges from 1 million to 2 million rupiah, while income >4 million occupies the smallest percentage. The community's main business of paddy farming often fails due to high water stagnation. Community efforts in managing *L. articulata* in peat swamp land are quite helpful in overcoming the phenomenon of declining rice yields. As much as 82.76% of village community members are involved in *L. articulata* management efforts. This phenomenon has an impact on the availability of jobs for the community. The average income from managing *L. articulata* by the community is IDR 1,721,000/ month or IDR 16,820,000/year. The average income of the community from businesses other than managing *L. articulata* is IDR 1,065,000/month or IDR 12,780,000/ year. The average total population income per year is IDR 29,600,000.-. So that the contribution of people's income from *L. articulata* business is 56.82%.

Ecological Characteristics

Vegetation characteristics found in the peat ecosystem are divided into three, namely secondary forest, *L. articulata* meadows and non- *L. articulata* open areas. The secondary forest formed formed a pure stand at the tree and pole level with species control >90%. The dominant vegetation level of trees and poles in the secondary forest is *Combretocarpus rotundatus*. Other species found in limited quantities are *Adina minutiflora, Alstonia pneumatophora*, *Syzygium* sp., *Melicope* sp., and *Pternadra azurea*. *C.rotundatus* was the most dominant species found in peatlands that had been repeatedly burned [27]. Undergrowth found

Table 3. Community income categories (1 USD = IDR 15.000,-).

Community Income (USD)	Percentage
16,67-133,33	56,25%
133,33-200	18,75%
200-266,67	15,63%
>267,67	9,37%
	100%

Table 4. Characteristics of Soil and Water in Peat Ecosystems (0-40 cm).

Land cover	Water pH	pH of peat	Groundwater level (cm)	Pyrite content
Secondary Forest	3.6	3.5	22.7	-
Purun Land	3.4	3.5	29.3	-
Open land which no *L.articulata*	4.5	4.8	61.7	+

Table 5. Variables and Indicators of Conservation.

No	Conservation Variable	Conservation Indicators	Value	%
1	The ecological value of the presence of *L.articulata* plant	- Ability to absorb water from the *L.articulata* area - Value of plant diversity - Pyrite content	2 1 3	67% 33% 100%
2	The social value of managing *L.articulata*	- Availability of community employment opportunities - Traditional skills of the local community	3 3	100% 100%
3	The economic value of managing *L.articulata*	- Revenue contribution - Materials used in the collection of *L.articulata*	2 3	67% 100%
4	Technical aspects related to planting materials and tools	- Materials used in the collection of *L.articulata* - Equipment used	3 3	100% 100%
5	Technical aspects related to harvesting materials and tools	- Materials used in the collection of *L.articulata* - Equipment used	3 3	100% 100%
6	Technical aspects related to the acquisition of raw materials	- *L.articulata* harvesting process - Amount of harvested *L.articulata* biomass	3 3	100% 100%
7	Other technical processes	- Land Preparation/Cleaning Process - Plant Maintenance Process - Post Harvest Process - Processing Product (*L.articulata* screening)	3 3 3 2	100% 100% 100% 67%
Total			34	90,24%

in the secondary forest include *Nepenthes mirabilis, Stenochlaena phalustris* and *L. articulata*.

Certain spots on the land cover of *L. articulata* are overgrown with *C.rotundatus* and *Adina minutiflora* with a limited number of individuals. Non-*L. articulata* open areas dominated by aquatic plants such as *Pistia stratiotes, Eichhornia crassipes*, *Ludwigia octovalvis*, *Scleria laevis*, *Phragmites karka*, and *Salvinia molesta*. Diversity index values (H') for all growth stages both in secondary forest, purun grasslands and non-purun open areas <1 (low category). Another ecological characteristic is the nature of the peat soil and water. Some of the physical and chemical properties of peat soil and water can be seen in Table 4.

The pH value of peat soil and water is included in the acid soil category. *L. articulata* can grow well in soils with acidic pH [28] and acid sulfate soils [19]. *L. articulata* plants can become indicator vegetation for acid sulfate soils because they are resistant to high acidity (pH 2.5-3.5). Maintaining forests in peat ecosystems is one of the mechanisms for reducing the height of waterlogging. The presence of *L. articulata* plants showed lower inundation than non- *L. articulata* open land. The inundation height that occurred in *L. articulata* land was relatively low and close to the secondary forest inundation height. Indications of the presence of pyrite were not found in *L. articulata* land and secondary forest, but in non- *L. articulata* open land there was an indication of pyrite content. *L. articulata* can absorb toxic compounds such as Fe and SO4 in water [20] *L. articulata* is able to absorb heavy metals such as Pb, Cd and Zn [19]. Rainfall in Haur Gading District is 2,667.40 mm. It was found that only 1 month was in the dry month category (rainfall intensity <60 mm), 11 months was included in the wet month category (rainfall intensity>100 mm), as a result the peat ecosystem became inundated. *L. articulata* still grows and develops in flooded soil conditions.

Support for Peat Ecosystem Conservation from *L. articulata* Management

Support for peat ecosystem conservation from *L. articulata* management is indicated through 7 variables and 17 indicators. The categories of conservation support in the management of *L. articulata* are ≤56% (low), >56%-78% (medium), >78% (high). The results of the identification of the role of group business forms on peat conservation can be seen in Table 5.

The results indicate that purun management is included in the category of supporting conservation.

Table 6. Classification of Ecosystem Service from Management of *L.articulata.*

Nu	Classification of Ecosystem Service	Description of Ecosystem Services Forms
1	Provisioning	Provision of natural fiber materials, Provision of natural medicine ingredients
2	Regulating	Water-absorbing plants (water regulation), Heavy metal-absorbing plants (water treatment), Carbon stocking and carbon sequestration (regulation for climate change), material of biodiversity (regulating of forest ecosystem)
3	Cultural	Traditional environmentally-friendly wetland agriculture system, traditional knowledge of weaving crafts, enhancing employment and entrepreneurial opportunities for the community.,
4	Supporting services	Management without cutting down trees, management without making drainage in peatland, maintaining the stability of the groundwater level.

The conservation value obtained from the management of *L. articulata* is the reduction in illegal logging activities in peat forests. This finding is similar to the efforts of the community of Rasau village in West Kalimantan to manage Aloe vera on thin peat (peat depth <50 cm) which can reduce access to illegal logging in peat ecosystems [29]. Management of *L. articulata* is also carried out without burning and without disturbing the peat water system. Apart from maintaining the management of *L. articulata*, a revegetation program needs to be carried out using many tree species that are adaptive to growing on peatlands. Revegetation with many types will increase plant diversity in peatlands. *S.balangeran* is an adaptive species that can grow well in peat ecosystems [30]. Several dominant and fast-growing tree species from peatlands also can be recommended as species of choice for revegetation on peatlands, such as *Cratoxylum glaucum*, *Garcinia rigida*, *Horsfieldia crassifolia, Camnosperma auriculatum* [31]. Classification of ecosystem service from Management of *L. articulata* such as provisioning, regulating, cultural and supporting services are clearly shown in Table 6.

Communities can be encouraged to use natural dyes in making handicrafts, so that the processing of woven materials from *L. articulata* becomes more environmentally friendly. There are several sources of natural dyes from plants. Communities in Central Kalimantan use rattan sap (*Daemonorop* sp.) as a natural dye for rattan matting [32]. Other community in Central Kalimantan shows that the farmer community obtained socioeconomic profiting from successful peatland cultivation and management [33]. The bark of *Ploiarium alternifolium, Artocarpus odoratissimus* is used by the people of West Kalimantan as a natural dye for woven bamboo and rattan crafts [34]. *L. articulata* woven can be categorized as a green product, because the process of planting, harvesting and processing is environmentally friendly. Increasing consumer awareness and concern for the environment influences their decision to pay higher prices for green products [35]. Increasing demand for various green products will increase income for the community.

L. articulata also has the potential as a natural medicinal ingredient. The ethanolic extract of the rhizome of *L. articulata* contained alkaloids, flavonoids, tannins, saponins, and anthraquinone compound [36]. The rhizome of *L. articulata* has antimalaria and antioxidant activity [37]. Traditional medicinal raw materials from plants are often constrained by scientific research in clinical trial research and standardization of these traditional medicinal raw materials [38].

Conclusions

The management of *L. articulata* is an alternative for community businesses that are developing due to the uncertainties faced in paddy rice farming. Various descriptions in this paper explicitly provide an explanation that the management of *L. articulata* carried out by the community is included in the category of supporting the conservation of peat ecosystems, such as the reduction of illegal logging activities in peat forests. As a form of biodiversity-based management that supports conservation, improvements need to be made regarding the community's capacity as *L. articulata* managers. Revegetation activities in the form of enrichment planting are an option to increase vegetation diversity in peat ecosystems. Conservation based on the utilization of the biodiversity of peat ecosystems by forest farmers can contribute to improving the socio-economic community and the environment.

Conflict of Interest

The authors declare no conflict of interest.

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