BIODIVERSITAS
Volume 23, Number 12, December 2022
Pages: 6180-6190

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d231212

Economic values of environmental services of three forest areas in South Ogan Komering Ulu District, South Sumatra, Indonesia

ENDA KARTIKA SARI[1,♥], ANDY MULYANA[2], MIRZA ANTONI[2], DESSY ADRIANI[2]
[1]Doctoral Program of Environmental Science, Graduate School, Universitas Sriwijaya, Jl. Padang Selasa No. 524, Bukit Besar, Palembang 30139, South Sumatra, Indonesia. Tel./fax.: +62-812-7872-0937, ♥email: endaunbara@gmail.com
[2]Department of Agribusiness, Faculty of Agriculture, Universitas Sriwijaya, Jl. Raya Palembang-Prabumulih Km 32, Indralaya, Ogan Ilir 30662, South Sumatra, Indonesia

Manuscript received: 13 October 2022. Revision accepted: 3 December 2022.

Abstract. *Sari EK, Mulyana A, Antoni M, Adriani D. 2022. Economic values of environmental services of three forest areas in South Ogan Komering Ulu District, South Sumatra, Indonesia. Biodiversitas 23: 6180-6190.* Forest provides environmental services in the form of provisioning, regulating, supporting and cultural services. However, forest is often valued from its timber products, neglecting its broader role in delivering environmental services especially its role in maintaining ecological functions. Forests in South Ogan Komering Ulu District, South Sumatra, Indonesia have high ecological importance in delivering environmental services, yet these forests are pressured by clearing and conversion into plantations and agriculture. The study aimed to comprehensively calculate the total economic value of environmental services delivered by three forest areas in South Ogan Komering Ulu, namely Gunung Raya Wildlife Reserve, Saka Production Forest and Saka Limited Production Forest. We calculated total economic value by incorporating the use value, which consists of direct use value and indirect use value, and the non-use value, which consists of option value, existence value and bequest value. The results revealed that the total economic value of the three forest areas is IDR 863,868,883,037. In more detail, the use value consisted of direct use value with IDR 354,378,792,460 contributing to 41.02% and indirect use value with IDR 509,309,370,324 contributing to 58.96% to the total economic value. The non-use value is from the option value, the existence value and bequest value with IDR 97,449,120 (0.01%), IDR 65,512,153 (0.01%) and IDR 17,758,980 (0.0021), respectively. Our study implies that forest has tremendous ecological functions which provide a very high economic value and environmental services, where these functions are often neglected.

Keywords: Economic valuation, environmental services, forest function, non-use value, use value

INTRODUCTION

Indonesia has abundant natural resources, which become essential factors in developing the economy of the country and improving the well-being of the people (Anggraeni et al. 2020; Shabbir et al. 2020; Liu et al. 2022). There are various benefits generated by natural resources (Phelps and Al 2014). Thus, the loss and deterioration of such resources would negatively impact people (Vassallo et al. 2021). Therefore, sustainable utilization of natural resources, as well as their conservation and protection, are important to impose to ensure the benefits can be delivered in perpetuity (Marchegiani et al. 2020). In some cases, the sustainable uses of natural resources require community involvement (Kim et al. 2019) since there are strong relationships between humans and the natural environment (Cord et al. 2017; Baciu et al. 2021).

The environment has three fundamental roles, namely (i) as a provider of natural resources to meet the needs of living things, (ii) as assimilator of waste discharged into the environment, (iii) and as the provider of environmental services (Baskent 2020; Coscieme and Stout 2018). From the perspective of anthropocentric, environmental services are defined as the benefits delivered by nature and enjoyed by humans (Campos et al. 2021). There are four types of environmental services, namely (i) provisioning services (e.g. the provider of wood, food, and clean water); (ii) supporting services (e.g. habitats of biodiversity; (iii) regulating services (e.g. erosion control, soil and hydrological protection, and carbon sequestration); (iv) cultural services (e.g. recreation and aesthetics) (Power 2010; Costanza et al. 2017; Garrett et al. 2022). In a good state, the environment might deliver various services necessary for humans, but unsustainable management might reduce the availability of the environment in delivering such services (Grizzetti et al. 2019). For example, overexploitation and habitat loss have been the major causes of the decline and extinction of biodiversity (Warseno 2015; Hynes et al. 2021). For this reason, an assessment of environmental services is necessary to see the state of the environment and its ability to provide benefits for humans. However, assessing environmental services is difficult because they do not have a price or market. For example, the ecological functions of tropical forests are needed by the community, yet they cannot be monetized (Daily 1997).

Economic assessment of environmental services can provide value to the environment, either in terms of benefits or losses and damage, so we can see whether the environmental management is conducted sustainably or not. In doing so, cost benefits analysis can be used to evaluate whether any activities are efficient, which affects the availability of environmental services. Achieving efficiency in economic development has a positive financial effect on the value of environmental services (Petrov et al. 2020). Determination of costs and benefits can be identified and monetized through non-market assessment, expert elicitation, and literature review (Sjöstrand et al. 2018) so that the quantitative result is expressed by monetary value (price). The valuation of natural resources and environmental services is diverse, including direct use value related to the managed natural resources and indirect use value consisting of biodiversity and ecosystem services (Laurans et al. 2013). This value calculation can also be done by calculating market prices, prices of replacing or substituting goods, and conducting surveys.

Forest is one ecosystem that delivers various environmental services (Baciu et al. 2021). It provides goods in the form of wood products, serves as a habitat for various flora and fauna, maintains hydrological systems, and so on. The broad range of environmental services delivered by forests are the result of the high biodiversity contained in them. Thus, the larger and better the condition of the forest, it would deliver good environmental services. Conversely, the smaller and more isolated forests will provide low services (Salles 2011; Valdés et al. 2020). However, many forests are cleared and intensively managed for other land uses, such as plantations and agriculture, to obtain economic and social benefits (Petrov et al. 2020), resulting in the deterioration of environmental services once it provided.

South Ogan Komering Ulu is a district in South Sumatra Province with high ecological importance. It is located in Bukit Barisan highland, has a mountainous and hilly landscape and serves as the upstream area of the Komering River Watershed (DAS) with a forest extent of 201,112.38 ha. The district also consists of Gunung Raya Wildlife Reserve (*Suaka Margasatwa*) and Saka production forest with a total extent of 30,887.62 ha. According to the Regulation of the Regent of South Ogan Komering Ulu Number 4 of 2015, it is stated that almost 60% of forest areas in Saka Production Forest (*Hutan Produksi/HP*), Saka Limited Production Forest (*Hutan Produksi Terbatas/HPT*), and Gunung Raya Wildlife Reserve have been damaged and converted into community plantation lands (KPH XIX Saka 2021). The forest conversion and degradation caused negative ecological impacts, namely landslides and flooding. Degradation is generally seen on hills and riverbanks. In some cases, it caused road blocking when landslides and flooding occurred. The forest area categorized as critical and very critical reached 13,732.64 ha.

Considering the degraded condition of the forest area in South Ogan Komering Ulu, it is imperative to assess the ecological and economic values of the existence of the forest. Forest clearing carried out by the community, depletion of forest resources, decreased biodiversity that provides many benefits to the community, and land degradation, in general, needs more attention (Kurowska et al. 2020). The study aimed to comprehensively calculate the total economic value of environmental services delivered by forest area in Saka production forest and Gunung Raya Wildlife Reserve from the ecological, economic and social functions. The importance of forests from an ecological perspective is represented by the role of forest ecosystems as the habitat of flora and fauna habitat and its role in maintaining the water supply, soil fertility, and clean air. From an economic perspective, the function of forest ecosystems is seen from the economic value of wood and animals, including the use and non-use values. From the social side, the role of forest ecosystems in creating peace and harmony in community relations. We expected the results of this study might serve as a baseline reference when planning and making decisions for the management of forest areas in South Ogan Komering Ulu District.

MATERIALS AND METHODS

Study area and period

This research was conducted in Gunung Raya Wildlife Reserve, Saka Limited Production Forest and Saka Production Forest, South Ogan Komering Ulu District, South Sumatra Province, Indonesia in March-July 2021. Geographically, South Ogan Komering Ulu District is located between 103022'-104021' East Longitude 04014'-04055 'LS. The topography of the South Ogan Komering Ulu District is mostly highlands in the form of hills and mountains. The altitude of the area ranges from 45-1,643 meters above sea level, with variations in annual rainfall between 2500-3000 mm/year and 3000-3500 mm/year, which are categorized as high rainfall. Most of the area in South Ogan Komering Ulu District is still forested, which is 278,659 hectares or around 50.72% of the district's area. The area used for settlements is 7,082 hectares and 1,706 hectares for roads, while for agriculture and plantations is 245,823 hectares. The area of rivers and inland waters is about 1.89% of the total area of 10,389 Ha. While about 1.04%, or an area of 5,735 hectares, is still in the form of shrublands. The population of South Ogan Komering Ulu District has always increased in line with the development progress. The main source of income for the majority of the population is from agriculture, whose main commodity is coffee. The average coffee plantation owned by farmers is 2 hectares with an average monthly income of IDR 3 million-IDR 4 million. Some residents work in the trading sector as civil servants and coffee-picking workers.

In this study, the scope of the research included several villages, namely Mekarjaya, Sido Rahayu, Durian Sembilan, Tanjung Jaya and Sinar Napalan (Figure 1).

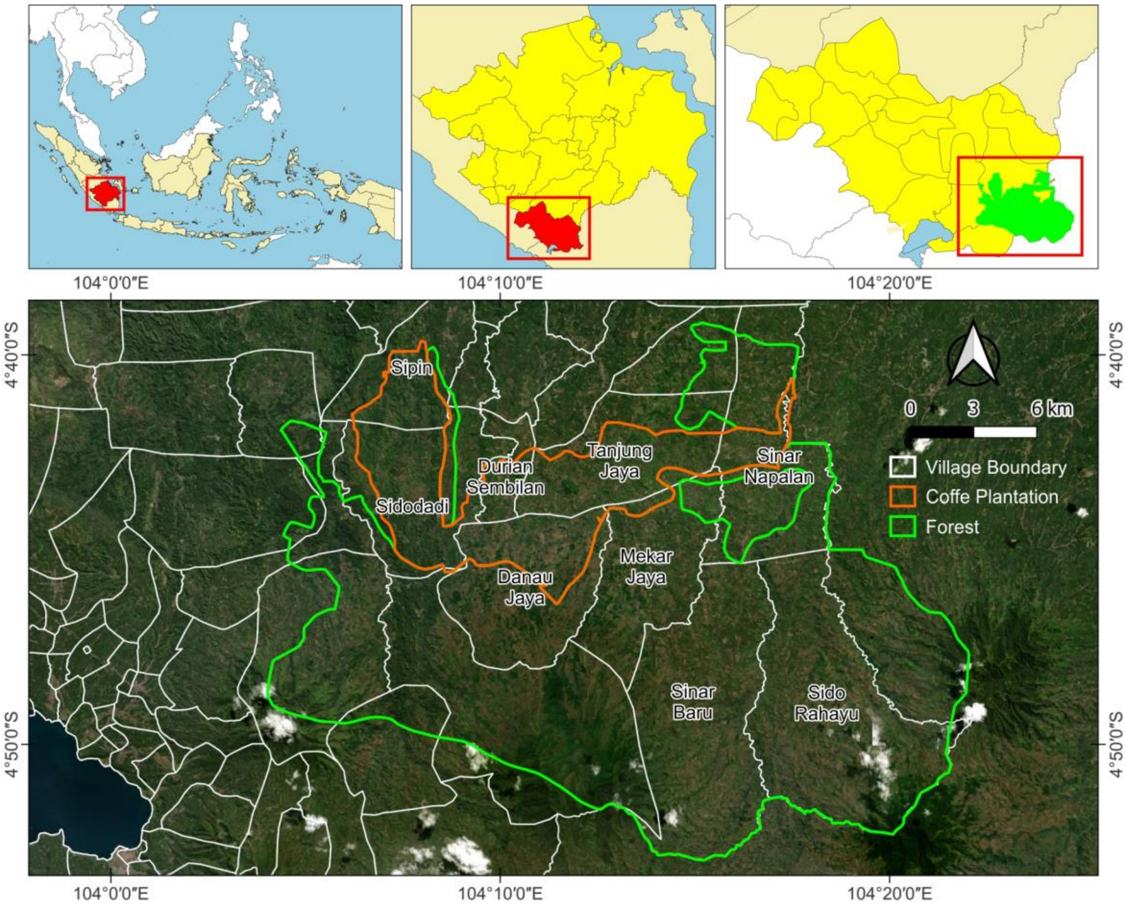

Figure 1. Map of the study area in South Ogan Komering Ulu District, South Sumatra Province, Indonesia

Data collection procedure

The data collection was undertaken using a survey technique involving household respondents. In this study, population sampling was carried out by Stratified Random Sampling. The criteria for selecting respondents were coffee farmers who had coffee plantations of 1-5 hectares with coffee plants aged 5-10 years, located on a slope of 15-25 degrees and shared boundaries with Gunung Raya Wildlife Reserve, Saka Production, and Saka Limited Production Forest. The total population is 1,829 heads of households (KK), with a sample of 270 heads of households determined using the Kreijce and Morgan tables.

The types of data collected in this research were primary and secondary data. Primary data were obtained through direct observation in the field by filling out questionnaires, interviews, observation and documentation. The questionnaire given to the respondents consisted of several questions about the identity of the respondent, the direct and indirect benefits that the respondent received from the forest area, the replacement cost of using clean water, the respondent's travel expenses to tourist attractions and other costs. Secondary data were obtained from related agencies, for example, the Research and Development Agency, the Central Bureau of Statistics (BPS), the Agriculture Service, the Plantations Service, the Forestry Service, the Public Housing and Public Works Service (PUPR) and other services in South OKU District.

Data analysis

The collected data was analyzed using quantitative and qualitative approaches. Qualitative data was analyzed descriptively using tabulation while quantitative data was analyzed to calculate the economic valuation of ecosystem services. There were two types of economic value: (i) use value which consisted of direct use value and indirect use value; and (ii) non-use value which consisted of option value, existence value and bequest value. In addition to the economic value, it is also necessary to calculate and assess the depletion of natural resources and the value of environmental damage as a side effect of economic activities carried out and achieve sustainable development (Pirmana et al. 2021). The calculation of each value is presented below.

Direct use value (DV)

This value was obtained from the direct benefits obtained from an ecosystem. The immediate economic value of the forest is mainly generated from wood and animal products reflected in market value.

$$DV = \Sigma DV_{(ky)} + \Sigma DV_{(hw)}$$

Where; $\Sigma DV_{(ky)}$ are amount of direct use value of the wood product (IDR/ha/year), $\Sigma DV_{(hw)}$ are amount of direct use value of the animal product (IDR/kg/year).

Indirect use value (IDV)

This value was obtained from the indirect use of the ecosystem. The indirect economic value of the forest area consists of the economic value of water absorption, carbon absorption, erosion control and soil nutrient provision.

$$IDV = \Sigma IDV_{(SA)} + \Sigma IDV_{(SK)} + \Sigma IDV_{(PB)} + \Sigma IDV_{(UH)}$$

Where; $\Sigma IDV_{(SA)}$ is indirect use value of water absorption (IDR/year), $\Sigma IDV_{(SK)}$ is the indirect use value of carbon absorption (IDR/year), $\Sigma IDV_{(PB)}$ is indirect use value of flood and erosion control (IDR/year), and $\Sigma IDV_{(UH)}$ is indirect use value of nutrient provider (IDR/year).

Option value (OV)

This value was obtained by using replacement costs, namely by calculating the transportation costs incurred using road access with the formula:

$$OV = \Sigma BP \times n$$

Where; ΣBP is Travel Cost Value (IDR/year), and n is the amount of travel cost (people/year)

Existences value (EV)

This value was obtained by using the respondent's willingness to pay in protecting wild animals using the following formula:

$$EV = \Sigma WTP \times n$$

Where; ΣWTP is the willingness to pay of respondent (IDR/year), and n is the amount forest area (hectare)

Bequest value (BV)

This was the benefits of recreation or tourism sites that can be passed on to the next generation, and calculated using the Travel Cost Method by the formula:

$$BV = \Sigma TCM \times n$$

Where; ΣTCM is Travel Cost (IDR/year), and n are amount of Travel Cost (people/year)

Total Economic Value (TEV)

The total economic value of was the sum of all values described above as follow:

Total economic value **(**TEV) = DV+IDV+OV+EV+BV

RESULTS AND DISCUSSION

Use value of forest

Use value is the economic value related to using natural resources directly or indirectly (Marulam 2021). It consists of direct and indirect use value.

Direct use value of forest

Wood and animal products

In this study, the incomes generated from wood products from the three forest areas is medang wood (*Litsea* sp.) and forest animals, namely deer (*Cervus unicolor*) and kijang (*Muntiacus muntjak*). The potential of *Litsea* sp. wood generated from Gunung Raya Wildlife Reserve is the highest compared to Raya production forests with 228 m^3/ha/year and estimated monetary value of IDR 235,324,900. *Litsea* sp. trees and the production process of *Litsea* sp. wood can be seen in Figure 2. The forest area has a reasonably high tree density with an average of 160 trees per hectare. The costs incurred in the three forest areas are the costs of cutting and transportation costs carried out on a wholesale basis. The average production produced is 200 m^3 with average costs of IDR 580,207.

The economic value generated from wood products in the bordered area with the Gunung Raya Wildlife Reserve is the highest because the trees that grow in this forest are quite dense, the resulting in high potential timber volume (Table 1). For example, one tree can produce ±5-7 m^3 of wood.

Other direct benefits of forests are generated from animals, namely *C. unicolor* and *M. muntjak*. The animals can be sold for the meat or consumed directly by the community. The Gunung Raya Wildlife Reserve had the highest potential of animals' products compared to the production and limited forest areas (Table 2). In addition, other fauna are also found, such as the Sumatran tiger (*Panthera tigris sumatra*), eagle (*Heliastur* sp.), Sumatran elephant (*Elephas maximus*) and sun bear (*Helarctos malayanus*).

The highest production and revenue are obtained from Gunung Raya Wildlife Reserve. When considering the cost, the average economic value generated from animal products in the three forest areas is IDR 7,168,864 (Table 3).

The total direct economic value obtained from the Gunung Raya Wildlife Reserve, Saka Production, and Saka Limited Production Forest area are the sum of products of wood and animals. The total direct economic value generated from the Gunung Raya Wildlife Reserve is the highest compared to that in the production and limited production forests. This is because the wildlife reserve has higher extent of area (897.60 ha) than the other two areas, namely 897.60 ha. The total direct economic value (wood and animal products) is presented in Table 4.

Indirect use value of forest

Indirect use value is the economic value gained from the indirect utilization of an ecosystem. The indirect use value of forest areas consists of the economic value of providing clean water, carbon absorption, erosion control, and nutrient supply.

Clean water supply

The ability of forests as water regulators can contribute to the provision of water to the community around the forest. In our study, Gunung Raya Wildlife Reserve and Saka Limited Production Forests have great potential to provide water resources. The benefits value of water for people in this forest area consists of the economic value of clean water for household needs.

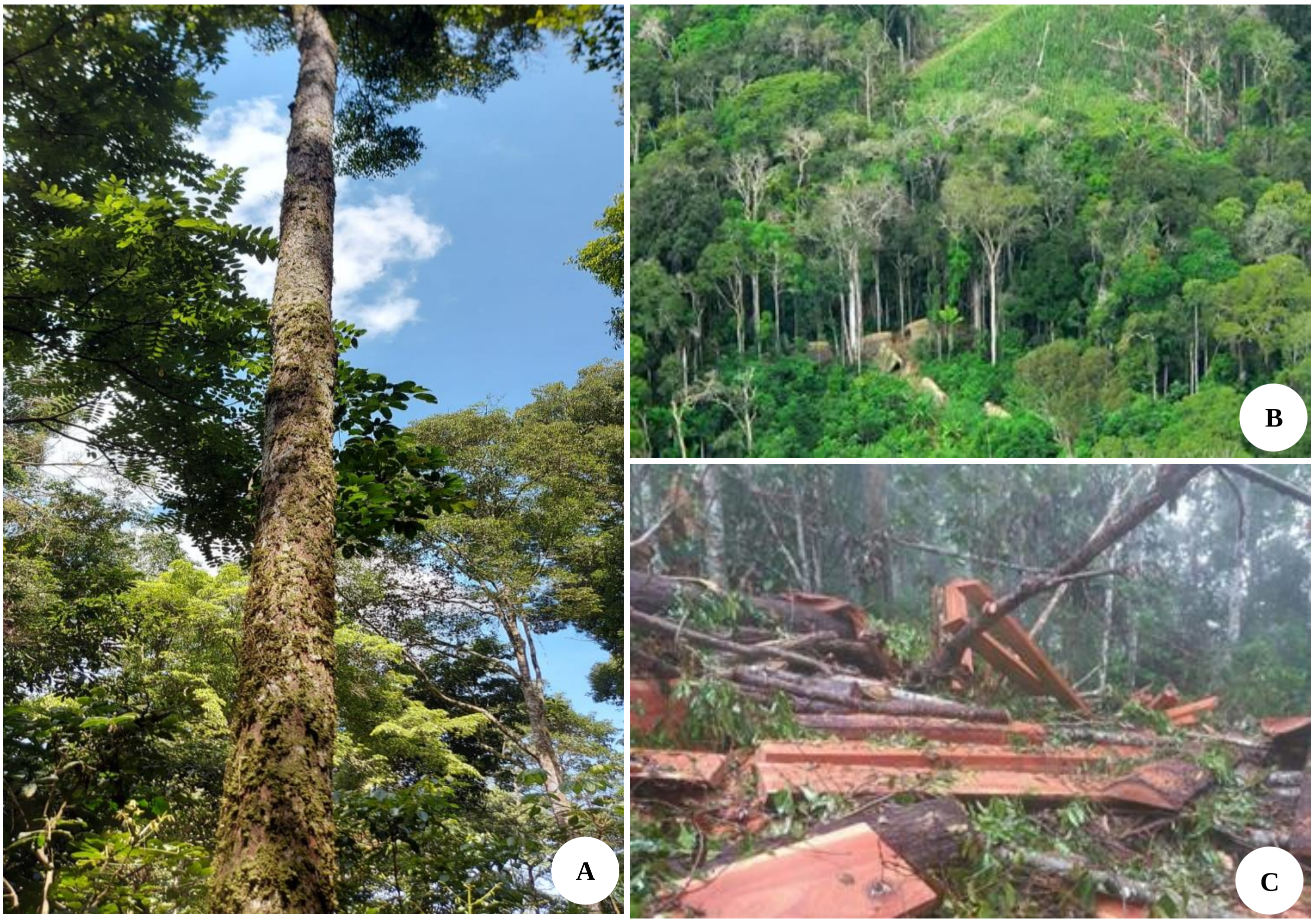

Figure 2. Economic value of *Litsea* sp. wood in the Gunung Raya and Saka forest areas, South Ogan Komering Ulu District, South Sumatra, Indonesia: A. *Litsea* sp. tree, B. *Litsea* sp. tree in forest area, C. Production of *Litsea* sp. wood

Table 1. Economic value from wood products in three forest areas in South Ogan Komering Ulu District, South Sumatra, Indonesia

Forest area	Wood production (m^3/ha/year)	Price (IDR/m^3)	Revenue (IDR/m^3/ha/year)	Cost (IDR/ha/year)	Economic value (IDR/ha/year)
	(1)	(2)	(3) = (1)*(2)	(4)	(5) = (3)-(4)
Gunung Raya Wildlife Reserve	195	1,095,053	235,324,900	589,181	234,735,719
Saka Limited Production Forest	212	1,077,129	227,318,855	582,524	226,736,331
Saka Production Forest	193	1,033,605	203,012,367	568,915.	206,306,852
Average	200	1,068,596	221,885,374	580,207	214,706,405

Table 2. Potential production and revenue from animal products in three forest areas in South Ogan Komering Ulu District, South Sumatra, Indonesia

Forest area	Production (kg/year)		Total Production	Price	Revenue (IDR/kg/year)		Total revenue
	C.unicolor	*M.muntjak*	(kg/year)	(IDR)	*C. unicolor*	*M. muntjak*	(IDR/kg/year)
	(1)	(2)	(3) = (1) + (2)	(4)	(5) = (1)*(4)	(6) = (2)*(4)	(7) = (5) + (6)
Gunung Raya Wildlife Reserve	228	45	273	28,768	6,554,432	1,302,193	7,476,799
Saka Limited Production Forest	225	31	256	29,322	6,623,039	903,078	7,526,117
Saka Production Forest	216	29	245	29,561	6,376,228	846,496	7,222,724
Sum	669	105	774	87,651	19,553,699	846,496	22,605,446
Average	223	35	258	29,217	6,517,900	1,017,256	7,535,155

Table 3. Economic value from animal products in three forest areas in South Ogan Komering Ulu District, South Sumatra, Indonesia

Forest area	Revenue (IDR/kg/year)		Cost (IDR/kg)		Economic value (IDR/kg/year)		Sum of economic value (IDR/kg/year)
	C. unicolor	*M. muntjak*	*C. unicolor*	*M. muntjak*	*C. unicolor*	*M. muntjak*	
	(1)	(2)	(3)	(4)	(5)=(1)-(3)	(6)=(2)-(4)	(7)=(5)+(6)
Gunung Raya Wildlife Reserve	6,554,432	1,302,193	334,570	62,705	6,219,862	1,239,488	7,476,799
Saka Limited Production Forest	6,623,039	903,078	345,949	44,204	6,302,692	858, 874	7,161,565
Saka Production Forest	6,376,228	846,496	312,170	42,325	6,064,058	804,171	6,868,229
Sum	19,517,900	3,051,767	992,689	149,234	18,586,612	2,902,533	21,506,593
Average	6,517,900	1,017,256	330,896	49,745	6,195,537	967,511	7,168,864

Table 4. Total direct economic value in three forest areas in South Ogan Komering Ulu District, South Sumatra, Indonesia

Forest area	Direct economic value of wood products (IDR/year) (1)	Direct economic value of animal products (IDR/year) (2)	Total direct economic value (IDR/year) (3) = (1) + (2)
Gunung Raya Wildlife Reserve	189,461,847,221	6,300,318,130	195,762,165,351
Saka Limited Production Forest	68,077,583,383	2,150,259,891	70,227,843,274
Saka Production Forest	85,541,010,045	2,847,773,790	88,388,783,835
Sum	343,080,440,649	11,298,351,811	354,378,792,460
Average	114,360,146,883	3,766,117,270	118,126,264,153

Clean water is a form of ecosystem services provided by nature that provide benefits for human life and other living things on this earth. Nonetheless, this form of ecosystem service is decreasing over time, although the level of dependence varies. Clean water is beneficial for the community's economic, environmental, and social aspects (Development 2018). The residents' needs for clean water in the South Ogan Komering Ulu District are partially provided by river water, and groundwater/wells provide most with depths ranging from 3-10 m. The need for clean water in some areas in the studied region have been served by the "Tirta Saka Selabung" drinking water company. To calculate the economic value of water provision in the forest area before it is opened into a coffee plantation can use the replacement cost method by looking at the needs of water use in the Gunung Raya Wildlife Reserve, Saka Limited Production Forest, and Saka Production Forest (Table 5).

Based on data from water intake in Tirta Saka Selabung, which serves the water needs of households in South Ogan Komering Ulu District in 2010, the amount of water production capacity of 107.5 L/s has been able to serve the needs of clean water for 3,911 households with average water consumption of 88 L/person/day. The water intake of Tirta Saka Selabung comes from the Saka River in South Ogan Komering Ulu District. The population of the study site is 1080 people x 88 L x 360 days = 34,214,400 L/person/year = 34,214.4 m^3/year x IDR 4,507 (rate in 2010). After being converted in 2020, the price becomes IDR 6,670, so the cost of meeting water needs per year is 34,214.4 m^3/year x IDR 6,670 = IDR 228,210,048/year. Similarly, research conducted by Roslinda et al. (2017) calculates the economic value of hydrology in the Tembawang ecosystem, namely 50% of the people consume water from Tembawang Ampar water sources, and the rest use sources with a hydrological, economic value of Rp. 21,970,080 per year.

Carbon absorption

Forest ecosystems play an important role in carbon sequestration and climate change. Carbon storage in forest areas is influenced by tree stand basal area (69.52%) and tree height (27.77%) (Balima et al. 2021). Carbon stock is the equivalent amount of CO_2 (CO_2-eq) stored in aboveground tree biomass per hectare. Carbon sequestration refers to the average change in the amount of CO_2-eq stored in aboveground biomass per hectare and per year (Naime et al. 2020). According to (Arico and Jayanthi 2016), one *Litsea* sp. contains biomass of 3.360 tons/ha with stored carbon of 1.680 tons/ha. Based on Carbon Rates 2021 published by The Organisation for Economic Cooperation and Development (OECD), the benchmark of the lowest carbon price of 30 euros per ton or around IDR 508,300/ton. The price per unit of carbon stock is around USD 0.76/ton with a 0% discount rate and a 6% interest rate of USD 1330.6/ton, and carbon sequestration is around USD 2,150.00 per hectare per year (Fuller and Dwivedi, 2021). Using the abovementioned references, the economic value of carbon absorption in the studied areas can be seen in Table 6. The result shows that the economic value of carbon absorption of tree stands in forest areas is highest in the Gunung Raya Wildlife Reserve because it has the largest extent.

The amount of carbon in the form of biomass represent carbon value. To minimize global warming, increased carbon monoxide levels in the air must be offset by the amount of carbon absorbed. The "time average" count on the soil surface in each system is reflected in the carbon dynamics of different land uses, which are interpreted as the value of carbon reserves. The carbon density in the forests of Shanghai (47.8 Mg/ha) and Hangzhou (30.25 Mg/ha) saw an increase in carbon storage from the previous decade. This is due to the rapid expansion of forest area, especially timber plantations, by 16% (Liang et al. 2022). Carbon sequestration of non-timber forest products has the potential to contribute to environmental services.

Erosion and flood control

Forests function as soil protectors from raindrops that fall to the ground and release soil grains so that erosion due to splashing rainwater can be reduced. Rainwater that does not penetrate into the ground will flow over the ground. This flow has a specific energy. The steeper and the more prolonged the slope where the water flows, the greater the energy. The energy present in surface runoff will expose the soil surface resulting in surface erosion.

Plant vegetation in the forest plays an important role in preventing erosion by blocking rainwater from falling directly into the ground, inhibiting surface flow and breaking rainwater splash, and strengthening absorption into the soil. In a study conducted by Cerdà et al. (2021), vegetation cover crops can reduce soil runoff, namely coccifera 4.87%, lentiscus 6.24%, parviflorus 13.41% and officinalis 13.84% were mediterranean bush plant spesies. Coccifera and lenticus plants are more efficient in controlling runoff discharge, while *Mucuna sp.* plants effectively reduce soil erosion by 74%-85%. Effective use of litter and mulch is beneficial in restoring soil properties, enzyme activity, soil biological value, and microbial properties in the soil. The cost of erosion control using *Mucuna sp.* mulch is IDR 1,640/ton of eroded soil (Jourgholami et al. 2021). Based on research that has been done (Agung et al. 2018), the amount of land that is eroded in forest areas amounts to 15 tons/ha/year, so the economic value that must be spent to overcome erosion is 15 tons/ha x IDR 1,640 x 1,612.48 ha = IDR 39,667,008/year. The economic value of erosion and flood control is summarized in Table 7.

Nutrient supply

Natural forests grow and develop through natural ecological processes in which there are no planting or exploitation activities. In natural forest, intact vegetation will maintain soil fertility trough nutrients cycling.

Table 5. The economic value in water provision in three forest areas in South Ogan Komering Ulu District, South Sumatra, Indonesia

Forest area	Replacement cost (IDR/year) (1)	Forest extent (ha) (2)	Economic value of water provision (IDR/year) (3) = (1) + (2)
Gunung Raya Wildlife Reserve	228,210,048	897.60	204,841,339,084
Saka Limited Production Forest	228,210,048	300.25	68,520,066,912
Saka Production Forest	228,210,048	414.63	1,274,654,664
Sum	684,630,144	192.14	274,636,060,061
Average	228,210,048	64.00	9,545,353,554

Table 6. The economic value in water provision in three forest areas in South Ogan Komering Ulu District, South Sumatra, Indonesia

Forest area	Carbon stock (ton/stems/ha) (1)	Number stand (stems/ha) (2)	Forest area (Ha) (3)	Carbon Price (IDR/ton) (4)	Economic value of carbon absorption (IDR/year) (5) =(1)+(2)+(3)+(4)
Gunung Raya Wildlife Reserve	1.680	160	897.60	508,300	122,640,021,504
Saka Limited Production Forest	1.680	160	300.25	508,300	41,023,469,760
Saka Production Forest	1.680	160	414.63	508,300	56,651,328,115
Sum	5.04	480	1.613	1,524,900	220,314,819,379
Average	1.680	160	538	508,300	74,438,273,126

Table 7. Economic value in erosion and flood control in three forest areas in South Ogan Komering Ulu District, South Sumatra, Indonesia

Forest area	Eroded land (ton/ha) (1)	Cost of erosion control (IDR/ton) (2)	Forest extent (ha) (3)	Economic value of erosion control (IDR/year) (4) = (1)+(2)+(3)
Gunung Raya Wildlife Reserve	15	1,640	897.60	22.082.436
Saka Limited Production Forest	15	1,640	300.25	7.386.150
Saka Production Forest	15	1,640	414.63	10.199.898
Sum	45	4,920	1.613	39.668.484
Average	15	1,640	538	13.222.828

Based on data from Puslitkoka Jember, soil in the South Ogan Komering Ulu forest area has C /N 9.1, Na 0.08, and elements K 4.28, Ca 5.12, and Mg 0.79. In the tropics, the nutrient content of the soil is quite good, consisting of elements of Ca (46%), Mg (46%), C (44%), N (35%), and K (30%) at a depth of 0-50 cm as topsoil needed by plants. High nutrient content can build biomass stocks in wood so that it can create a good forest area (Gray and Bond 2015). The nutrients cycle in natural forest comes from leaf litter. The production of litter in tropical forests generally ranges from 12 tons/ha/year. Assuming that the price of subsidized organic fertilizer is IDR 500/kg, the total indirect economic value of the forest area in nutrient supply can be calculated.

Having all components of indirect economic value of forest are calculated as presented above, the sum of total indirect economic value of forest area in South Ogan Komering Ulu can be seen in Table 8.

Non-Use Value of Forests

Non-use value is the economic value obtained from non-production processes, and the focus of non-use value is not related to profitable economic outcomes (Hansson et al. 2018). It consists of option value, existence value and bequest value.

Option value

Option value is the economic value obtained from the potential for direct or indirect utilization of an ecosystem in the future. In this study, the option value in the forest areas is road access and transportation. Forest areas that the community has opened into coffee plantations and settlements provide positive benefits on creating road. Road access at the research site has significantly improved over the last three years. The new road path (Jagaraga Street) saves 15 km from the old line. The distance to the study area is 35 km from Jagaraga Street which can be reached in 45-60 minutes and can be reached by motorcycle and car. Main road with excellent condition is built with concrete and asphalt and have reached the locations of community-owned coffee plantations, mainly at an altitude of 600-800 m above sea level. This distance requires gasoline fuel as much as 8 L (round trip) to the research site. Using the replacement cost method, the cost of road access and transportation is obtained by calculating transportation costs incurred to travel. Travel cost is obtained by calculation of 8 L of gasoline x IDR 4,500 = IDR 36,000 (price in 2010) and converted price in 2020 IDR 53,280 (with Conversion Factor of 1.48) (Table 9).

Existence value

Existence value is the economic value derived from the people perception on the benefits of ecosystem existence, regardless it exists or not. In this study, the perceived benefits of the existence of the forests were calculated using the contingent valuation method refers to the market price by giving several questions to respondents to provide an assessment of the value of forest existence. It was done by conducting an in-depth interview by asking about the willingness of respondents to pay (willingness to pay) in protecting wildlife in the forest and maintaining the forest existence. The willingness of the respondents to pay for the existence of Gunung Raya Wildlife Reserve reach IDR 36,364, in Saka Limited Production Forest amounted to IDR 46,429 and in Saka Production Forest amounted to IDR 43,750, so the total willingness to pay is IDR 126,543 with an average of IDR 42,181. Multiplying by the extent of each forest, the economic value of forest existence amounted to IDR 65,512,153 with an average of IDR 21,837,384 (Table 10).

Table 8. Total indirect economic value of three forest areas in South Ogan Komering Ulu District, South Sumatra, Indonesia

Forest area	EV of water provision (IDR/year) (1)	EV of carbon absorption (IDR/year) (2)	EV of erosion control (IDR/year) (3)	EV of nutrient supply (IDR/year) (4)	Total indirect economic value (IDR/year) (5) = (1)+(2)+(3)+(4)
Gunung Raya Wildlife Reserve	204,841,339,084	122,640,021,504	22,082,436	7,970,688,000	335,474,131,024
Saka Limited Production Forest	68,520,066,912	41,023,469.760	7,386,150	2.666.220.000	112,217,142,822
Saka Production Forest	1,274,654,664	56,651,328,115	10,199,898	3,681,914,400	61,618,097,077
Sum	274,636,060,660	220,314,819,379	39,668,484	14,318,822,400	50,309.370.923
Average	91,545,353,553	73,438,273,126	13,222,828	4,775940.800	169,769.790.308

Table 9. Economic value of road access and transportation in three forest areas in South Ogan Komering Ulu District, South Sumatra, Indonesia

Forest area	Transportation cost per household (IDR/HH/year) (1)	Number of households (HH) (2)	Economic value of road Access and transportation (IDR/year) (3) = (1)*(2)
Gunung Raya Wildlife Reserve	53,280	895	47,685,600
Saka Limited Production Forest	53,280	660	35,164,800
Saka Production Forest	53,280	274	14,598,720
Sum	159,840	1.829	97,449,120
Average	53,280	610	32,483,040

Table 10. Economic value of forest existence in three forest areas in South Ogan Komering Ulu District, South Sumatra

Forest area	Willingness to pay (IDR/ha/year) (1)	Forest extent (Ha) (2)	Economic value of forest existence (IDR/year) (3) = (1)*(2)
Gunung Raya Wildlife Reserve	36,364	897.60	32,640,326
Saka Limited Production Forest	46,429	595.68	27,656,827
Saka Production Forest	43,750	119,2	5,215,000
Sum	126,543	1.613	65.512,153
Average	42,181	538	21,837,384

Table 11. Economic Value of tourism potential in three forest areas in South Ogan Komering Ulu District, South Sumatra

Forest area	Travel cost (IDR/year) (1)	Number of trips (2)	Economic value of tourism potential (IDR/year) (3) = (1)*(2)
Gunung Raya Wildlife Reserve	65,774	132	8,682,168
Saka Limited Production Forest	65,774	98	6,445,852
Saka Production Forest	65,774	40	2,630,960
Sum	197,322	270	17,758,980
Average	65,774	90	5,919,660

Table 12. Total economic value of three forest areas in South Ogan Komering Ulu District, South Sumatra

Component	Economic value (IDR)	Percentage (%)
Use value		
Direct use value		
Wood products	343,080,440,649	39.71
Animal products	11,298,351.811	1.31
Total	354,378,792,460	41.02
Indirect use value		
Clean water provision	274,636,060,061	31.79
Carbon absorption	220,314.819,379	25.50
Erosion and flood control	39,668,484	0.005
Nutrient supply	14,318,822,400	1.66
Total	509,309,37,.324	58.96
Total usage value	*863,688,162,784*	*99.98*
Non-use value		
Option value		
Road access and easy transportation	97,449,120	0.01
Total	97,449,120	
Existence value	65,512,153	0.01
Total	65,512,153	
Bequest value		
Recreation/tourism potential	17,758,980	0.0021
Total	17,758,980	
Total non-use value	*180,720,253*	*0.02*
Total economic value	**863,868,883,037**	**100,00**

Bequest value

Bequest value is the economic value obtained from the utilization of ecosystem preservation to benefit future generations, including recreation/tourism potential in the future as part of heritage. Gunung Raya Wildlife Reserve has a magnificent recreational potential to enjoy. The natural charm of the waterfall in a forest area surrounded mainly by *Litsea* sp. wood trees in the Gunung Raya area is a heritage value that can be passed down to the next generation. Anna and Saputra (2017) revealed that in assessing tourist attractions, in this case, the Cendrawasih Bay National Park, it is necessary to diversify tourism products and distribute tourist destinations. Also, investment breakthroughs are needed to develop remote areas. The value of this area can also be a proxy for the cost of managing and mitigating the damage or the cost of compensation for the damage that has been or will occur. The value also implies the projected restoration costs if the resource is damaged. Environmental services must be identified as the driving function of forest (Chibwana et al. 2012) including changes in carbon stocks, climate, hydrological systems, and biodiversity (Hansen et al. 2008).

To calculate the economic value of the potential recreation/tourism, the Travel Cost Method (TCM) is widely used to assess non-use benefits by calculating individual expenses for a trip. TCM is usually used to determine the non-use component of a recreational place by considering the trip to recreational place. The distance to the Sidorahayu Waterfall Recreation area if the forest condition has not been opened is ± 50 km from the provincial road. The road, which is in damaged condition, can only be reached by mountain bike which takes 3-4 hours to the tourist site-the fuel needed to cover that distance ± 8 L. The economic value of potential tourism forest areas can be seen in Table 11.

Having all the values calculated, the total economic value of the forest areas studied can be obtained. The use-value consisted of direct use value with IDR 354,378,792,460 contributing to 41.02% and the indirect use value with IDR 509,309,370,324 contributing to 58.96% to the total economic value. The non-use value is from the option value, the existence value and bequest value with IDR 97,449,120 (0.01%), IDR 65,512,153 (0.01%) and IDR 17,758,980 (0.0021), respectively. The total economic value of the three forests area is IDR 863,868,883,037 (Table 12).

In conclusion, the economic use value, namely direct use value and indirect use value, contributes a tremendous economic value to the forest area with 99.98%, and the remaining 0.02% is contributed from the non-use value. The most significant portion is contributed by the indirect economic value in the form of ecological functions of the forest areas in providing water, controlling erosion and flooding, high carbon absorption, and supplying nutrients for the soil, which contributes to 58.96% of the total economic value. This finding shows that forest has ecological functions which provides a very high economic value and environmental services, where these functions are often neglected. For this reason, it is necessary to carry out sustainable forest management and, of course, always pay attention to the function of forest environmental services.

REFERENCES

Agung R, Rahayu Y, Saputro T, Tjandrakirana R, Ramdhany D, Wibawa M, Silitonga TCR, Damarraya A, Wulandari EY, Anisah LN, Margono BA, Setyawan H, Sofyan, Sumantri, Suprapto U, Famuria E, Zahrul M, Muttaqin. 2018. Status hutan dan kehutanan Indonesia, Kementerian Lingkungan Hidup dan Kehutanan RI. [Indonesian]

Anggraeni P, Daniels P, Davey P. 2020. Improving the benefit of natural resources endowment to economic welfare in Indonesia: A mixed-method analysis. Intl J Adv Sci Eng Inf Technol 10: 1234-1244. DOI: 10.18517/ijaseit.10.3.12067.

Anna Z, Saputra DS. 2017. Economic valuation of whale shark tourism in Cenderawasih Bay National Park, Papua, Indonesia. Biodiversitas 18 (3): 1026-1034. DOI: 10.13057/biodiv/d180321.

Arico Z, Jayanthi S. 2016. Potensi karbon tersimpan hutan Taman Nasional Gunung Leuser Resort Tenggulun sebagai upaya mitigasi perubahan iklim. Elkawnie 2: 143. DOI: 10.22373/ekw.v2i2.2660. [Indonesian]

Baciu GE, Dobrotă CE, Apostol EN. 2021. Valuing forest ecosystem services. Why is an integrative approach needed? Forests 12. DOI: 10.3390/f12060677.

Balima LH, Kouamé FNG, Bayen P, Ganamé M, Nacoulma, BMI, Thiombiano A, Soro D. 2021. Influence of climate and forest attributes on aboveground carbon storage in Burkina Faso, West Africa. Environ Chall 4 (April): 100123. DOI: 10.1016/j.envc.2021.100123.

Baskent EZ. 2020. A framework for characterizing and regulating ecosystem services in a management planning context. Forests 11 (1): 102. DOI: 10.3390/f11010102.

Campos FS, David J, Lourenço-de-Moraes R, Rodrigues P, Silva B, Vieira da Silva C, Cabral P. 2021. The economic and ecological benefits of saving ecosystems to protect services. J Clean Prod 311. DOI: 10.1016/j.jclepro.2021.127551.

Cerdà A, Lucas-Borja ME, Franch-Pardo I, Úbeda X, Novara A, López-Vicente M, Popović Z, Pulido M. 2021. The role of plant species on runoff and soil erosion in a Mediterranean shrubland. Sci Total Environ 799: 149218. DOI: 10.1016/j.scitotenv.2021.149218.

Chibwana C, Jumbe CBL, Shively G. 2012. Agricultural subsidies and forest clearing in Malawi. Environ Conserv 40 (1): 60-70. DOI: 10.1017/S0376892912000252.

Cord AF, Bartkowski B, Beckmann M, Dittrich A, Hermans-Neumann K, Kaim A, Lienhoop N, Locher-Krause K, Priess J, Schröter-Schlaack C, Schwarz N, Seppelt R, Strauch M, Václavík T, Volk M. 2017. Towards systematic analyses of ecosystem service trade-offs and synergies: Main concepts, methods and the road ahead. Ecosyst Serv 28: 264-272. DOI: 10.1016/j.ecoser.2017.07.012.

Coscieme L, Stout JC. 2018. Ecosystem services evaluation, 2nd ed, Encyclopedia of Ecology. Elsevier Inc. DOI: 10.1016/B978-0-12-409548-9.10967-4.

Costanza R, de Groot R, Braat L, Kubiszewski I, Fioramonti L, Sutton P, Farber S, Grasso M. 2017. Twenty years of ecosystem services: How far have we come and how far do we still need to go? Ecosyst Serv 28: 1-16. DOI: 10.1016/j.ecoser.2017.09.008.

Daily. 1997. Nature's Services: Societal dependence on natural ecosystems (Chapter 6).

Development E. 2018. A Survey 133-144.

Fuller M, Dwivedi P. 2021. The Cost of Carbon Stored on Afforested Lands in the Southern United States. Trees, Forests and People 6: 100129. DOI: 10.1016/j.tfp.2021.100129.

Garrett RD, Grabs J, Cammelli F, Gollnow F, Levy SA. 2022. Should payments for environmental services be used to implement zero-deforestation supply chain policies? The case of soy in the Brazilian Cerrado. World Dev 152: 105814. DOI: 10.1016/j.worlddev.2022.105814.

Gray EF, Bond WJ. 2015. Soil nutrients in an African forest/savanna mosaic: Drivers or driven? S Afr J Bot 101: 66-72. DOI: 10.1016/j.sajb.2015.06.003.

Grizzetti B, Liquete C, Pistocchi A, Vigiak O, Zulian G, Bouraoui F, De Roo A, Cardoso AC. 2019. Relationship between ecological condition and ecosystem services in European rivers, lakes and coastal waters. Sci Total Environ 671: 452-465. DOI: 10.1016/j.scitotenv.2019.03.155.

Hansen MC, Stehman SV, Potapov PV, Loveland TR, Townshend JRG, Defries RS, Pittman KW, Arunarwati B, Stolle F, Steininger MK, Carroll M, Dimiceli C. 2008. Humid tropical forest clearing from 2000 to 2005 quantified by using multitemporal and multiresolution remotely sensed data. Proc Natl Acad Sci 105 (27): 9439-9444. DOI: 10.1073/pnas.0804042105.

Hansson H, Lagerkvist CJ, Azar G. 2018. Use and non-use values as motivational construct dimensions for farm animal welfare: Impacts on the economic outcome for the farm. Animal 12 (10): 2147-2155. DOI: 10.1017/S175173111700372X.

Hynes S, Chen W, Vondolia K, Armstrong C, O'Connor E. 2021. Valuing the ecosystem service benefits from kelp forest restoration: A choice experiment from Norway. Ecol Econ 179: 106833. DOI: 10.1016/j.ecolecon.2020.106833.

Jourgholami M, Feghhi J, Picchio R, Tavankar F, Venanzi R. 2021. Efficiency of leaf litter mulch in the restoration of soil physiochemical properties and enzyme activities in temporary skid roads in mixed high forests. Catena 198 (October): 105012. DOI: 10.1016/j.catena.2020.105012.

Kim M, Xie Y, Cirella GT. 2019. Sustainable transformative economy: Community-based ecotourism. Sustain 11: 1-15. DOI: 10.3390/su11184977.

Kurowska K, Kryszk H, Marks-Bielska R, Mika M, Leń P. 2020. Conversion of agricultural and forest land to other purposes in the context of land protection: Evidence from Polish experience. Land Use Policy 95: 104614. DOI: 10.1016/j.landusepol.2020.104614.

Laurans Y, Rankovic A, Billé R, Pirard R, Mermet L. 2013. Use of ecosystem services economic valuation for decision making: Questioning a literature blindspot. J Environ Manage 119: 208-219. DOI: 10.1016/j.jenvman.2013.01.008.

Liang B, Wang J, Zhang Z, Zhang J, Zhang J, Cressey EL, Wang Z. 2022. Planted forest is catching up with natural forest in China in terms of carbon density and carbon storage. Fundam Res 2 (5): 688-696. DOI: 10.1016/j.fmre.2022.04.008.

Liu Q, Zhao Z, Liu Y, He Y. 2022. Natural resources commodity prices volatility, economic performance and environment: Evaluating the role of oil rents. Resour Policy 76: 102548. DOI: 10.1016/j.resourpol.2022.102548.

Marchegiani P, Morgera E, Parks L. 2020. Indigenous peoples' rights to natural resources in Argentina: the challenges of impact assessment, consent and fair and equitable benefit-sharing in cases of lithium mining. Intl J Hum Rights 24: 224-240. DOI: 10.1080/13642987.2019.1677617.

Naime J, Mora F, Sánchez-Martínez M, Arreola F, Balvanera P. 2020. Economic valuation of ecosystem services from secondary tropical forests: trade-offs and implications for policy making. For Ecol Manag 473 (June): 118294. DOI: 10.1016/j.foreco.2020.118294.

Petrov V, Bogatova E, Filinova I. 2020. Economic estimation of forest recreation. IOP Conf Ser Earth Environ Sci 574 (1): 012063. DOI: 10.1088/1755-1315/574/1/012063.

Phelps J, Al E. 2014. A framework for assessing supply-side wildlife conservation. Conserv Biol 28 (1): 244-257. DOI: 10.1111/cobi.12160.

Pirmana V, Alisjahbana AS, Yusuf AA, Hoekstra R, Tukker A. 2021. Environmental costs assessment for improved environmental-

economic account for Indonesia. J Cleaner Prod 280: 124521. DOI: 10.1016/j.jclepro.2020.124521
Power AG. 2010. Ecosystem services and agriculture: Tradeoffs and synergies. Philos Trans R Soc B Biol Sci 365: 2959-2971. DOI: 10.1098/rstb.2010.0143.
Roslinda E, Kartikawati SM, Rabudin. 2017. Economic valuation for tembawang ecosystem, in Sanggau district, West Kalimantan, Indonesia. Biodiversitas 18 (4): 1506-1516. DOI: 10.13057/biodiv/d180429.
Saka KX. 2021. Rencana pengelolaan hutan jangka pendek kesatuan pengelolaan hutan produksi unit XIX Saka. RPHJP KPH unit XIX Saka 2013-2015. [Indonesian]
Salles JM. 2011. Valuing biodiversity and ecosystem services: Why put economic values on nature? Comptes Rendus-Biol 334: 469-482. DOI: 10.1016/j.crvi.2011.03.008.
Shabbir A, Kousar S, Kousar F. 2020. The role of natural resources in economic growth: new evidence from Pakistan. J Econ Finance Adm Sci 25: 221-238. DOI: 10.1108/JEFAS-03-2019-0044.
Sjöstrand K, Lindhe A, Söderqvist T, Rosén L. 2018. Sustainability assessments of regional water supply interventions-Combining cost-benefit and multi-criteria decision analyses. J Environ Manag 225: 313-324. DOI: 10.1016/j.jenvman.2018.07.077.
Valdés A, Lenoir J, De Frenne P, Andrieu E, Brunet J, Chabrerie O, Cousins SAO, Deconchat M, De Smedt P, Diekmann M, Ehrmann S, Gallet-Moron E, Gärtner S, Giffard B, Hansen K, Hermy M, Kolb A, Le Roux V, Liira J, Lindgren J, Martin L, Naaf T, Paal T, Proesmans W, Scherer-Lorenzen M, Wulf M, Verheyen K, Decocq G. 2020. High ecosystem service delivery potential of small woodlands in agricultural landscapes. J Appl Ecol 57 (1): 4-16. DOI: 10.1111/1365-2664.13537.
Vassallo P, Turcato C, Rigo I, Scopesi C, Costa A, Barcella M, Dapueto G, Mariotti M, Paoli C. 2021. Biophysical Accounting of Forests ' Value under Different Management Regimes : Conservation vs Exploitation. Sustainability 13 (9): 4638. DOI: 10.3390/su13094638.
Warseno T. 2015. Konservasi ex situ secara in-vitro jenis-jenis tumbuhan langka dan kritis di Kebun Raya "Eka Karya" Bali. Pros Sem Nas Masy Biodiv Indon 1: 1075-1082. DOI: 10.13057/psnmbi/m010518. [Indonesian]