

An Economic Valuation Analysis Of Mangrove Forest Ecosystem Presence

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Abstract

Mangrove ecosystems are often treated as public resources, accessible for use without consideration for their sustainability. This study aims to evaluate the utilization and total economic value of the mangrove ecosystem in Jenggalu Kito Village, Bengkulu City. The assessment covers Direct Economic Benefits, Indirect Benefits, Optional Benefits, and the Existence Value of the Mangrove Ecosystem in the village. A quantitative descriptive research design was employed, utilizing data collected through questionnaires, interviews, observations, and documentation. The study population consisted of 32 individuals, including 20 fishermen whose primary livelihood depends on the mangroves, and 12 others with secondary livelihoods in the village, with a census method technique applied for data collection.

Funding: This research was supported by [insert funding source], which provided the necessary resources for data collection and analysis. The novelty of this research lies in its comprehensive approach to quantifying the economic value of mangrove ecosystems in a specific local context, highlighting the significance of both direct and indirect benefits in sustaining the livelihoods of local communities. The objective of this study is to provide a detailed economic valuation of the mangrove ecosystem in Jenggalu Kito Village, which can serve as a foundation for sustainable management practices and policy formulation to ensure the long-term preservation of these critical natural resources. The findings reveal that the direct utilization of the mangrove forest generates a value of IDR 521,925,421 per month, accounting for 93.0% of the total economic value. Indirect benefits contribute IDR 36,931,390 per month (6.6%), while Optional Benefits and Existence Value are estimated at IDR 1,153,167 (0.2%) and IDR 1,130,000 (0.2%) per month, respectively. These results underscore the economic importance of mangrove ecosystems and the need for sustainable management to preserve their value for future generations.

Keywords: Economic Valuation, Mangrove Ecosystem, Jenggalu Kito Village

INTRODUCTION

Mangrove ecosystems are vital coastal environments that provide critical protection against natural disasters such as coastal erosion, storm surges, and floods. These ecosystems serve as natural buffers that safeguard coastal communities from the impacts of climate change, including rising sea levels and increased storm intensity (Alongi, 2020). Proper management of mangrove ecosystems is essential to enhance coastal resilience while simultaneously supporting sustainable economic development, as mangroves offer a variety of ecosystem services, both direct and indirect, to surrounding communities (Barbier, 2016). As these ecosystems serve as nurseries for marine species, they are indispensable for biodiversity conservation and play a key role in the local economy through fisheries and timber resources (Sumartono & Sugara, 2021).

Indonesia is home to approximately 27% of the world's mangrove ecosystems, making it a key player in global mangrove conservation efforts. However, rapid population growth and extensive coastal development for agriculture, aquaculture, infrastructure, and settlements have exerted significant pressure on these ecosystems, leading to both direct and indirect degradation (Litolily, et al., 2020; Agustini, et al., 2024). This degradation threatens not only the ecological integrity of the mangroves but also their role in maintaining biodiversity and providing crucial resources for local communities (Yañez-Arancibia & Day, 2018). The novelty of this research lies in its focus on evaluating the comprehensive Total Economic Value (TEV) of the mangrove ecosystem, an approach not often utilized in Indonesian mangrove studies.

Mangrove ecosystems offer immense potential for improving human well-being by contributing to economic, social, and environmental sustainability. However, excessive deforestation and land conversion for development projects in coastal areas of Indonesia have exacerbated the vulnerability of these ecosystems, diminishing their ability to provide essential services such as carbon sequestration and habitat preservation for marine species (Alongi, 2020; Sugara & Sumartono, 2021). This loss has far-reaching consequences for environmental stability and economic livelihoods.

The mangrove forest ecosystem also plays an essential role in sustaining local economies. It provides raw materials, including wood and fishery resources, and supports industries such as coastal tourism and aquaculture (Mursalam, 2021). Economically, mangroves contribute through direct uses, such as harvesting for timber and fisheries, as well as indirect benefits, such as storm protection and biodiversity conservation (Kharina, et al., 2018). The total economic value (TEV) of mangrove ecosystems, including direct and indirect use values, option values, and existence values, highlights the multifaceted importance of mangroves for both local communities and the broader economy (Wanda, et al., 2019).

Given their significant economic and environmental value, it is crucial to assess and quantify the total economic value of mangrove ecosystems to guide better management practices. A comprehensive understanding of these values can inform policymakers and stakeholders in developing sustainable utilization strategies that benefit both the ecosystem and the communities that depend on them (Tahang & Amir, 2018; Sumartono et al., 2021). This study aims to evaluate the economic value of the mangrove ecosystem in Jenggalu Kito Village, Bengkulu, which will serve as a reference for future conservation and management efforts.

METHOD

This research was conducted in Jenggalu Kito Village, Gading Cempaka District, Bengkulu City. The research site is known for its extensive mangrove tree growth along the swamps, where the local community actively utilizes the mangrove ecosystem for various livelihood activities. These include harvesting resources provided by the mangrove ecosystem, which contributes to the socio-economic welfare of the local population (Alongi, 2020).



Figure 1. Research Location Map

Source: Google Maps

The research involved local residents of Jenggalu Kito Village, who were surveyed during the data collection process through questionnaires. This study employed a descriptive survey method. Both primary and secondary data were utilized. Primary data were collected through the administration of questionnaires to 20 respondents, accompanied by interviews and direct field observations to capture the local context. Direct data collection in the field is critical for obtaining accurate insights into the utilization of mangrove resources by the local community (Simau et al., 2020).

The primary research focuses on eight fields of study related to the utilization of the mangrove ecosystem, as identified by Simau et al. (2020). These include: (a) fish catches, (b) crab catches, (c) shrimp catches, (d) mollusk catches, (e) mangrove tea production, (f) mangrove seed collection, and (g) mangrove chip production. Data were collected through direct interviews with local fishermen, using questionnaires as the main instrument for data gathering (Barbier, 2016).

Secondary data were sourced from relevant institutions and agencies that provide official data and reports. The sampling technique employed was a census method, in which the entire population was included as the sample

(Yañez-Arancibia & Day, 2018). Before calculating the total economic value (TEV) of the mangrove ecosystem, the following formulas were used:

1. **Direct Benefits (DB)**

$$DB1 + DB2 + DB3 + DB4 = DB$$

Where:

DB1: Direct Benefit of Fish

DB2: Direct Benefit of Shrimp

DB3: Direct Benefit of Crabs

DB4: Direct Benefit of Mollusks

2. **Indirect Benefits (IB)**

$$IB1 + IB2 = IB$$

Where:

IB1: Nursery Ground, Feeding Ground, and Spawning Ground Benefits

IB2: Benefits as Erosion Control and Pond Protection

3. **Option Benefits (OB)**

$$OB1 + OB2 + OB3 = OB$$

Where:

OB1: Mangrove Tea Production

OB2: Mangrove Chips Production

OB3: Mangrove Seed Collection

4. **Existence Benefits (EB)**

The community's willingness to pay for the conservation of the mangrove forest. This value is obtained through voluntary contributions from local residents to support the preservation of the mangrove ecosystem in their surroundings.

The total economic value (TEV) of the mangrove ecosystem is calculated using the following formula (Puspita, 2015):

$$TEV = DB + IB + OB + EB$$

Where:

DB: Direct Benefits

IB: Indirect Benefits

OB: Option Benefits

EB: Existence Benefits

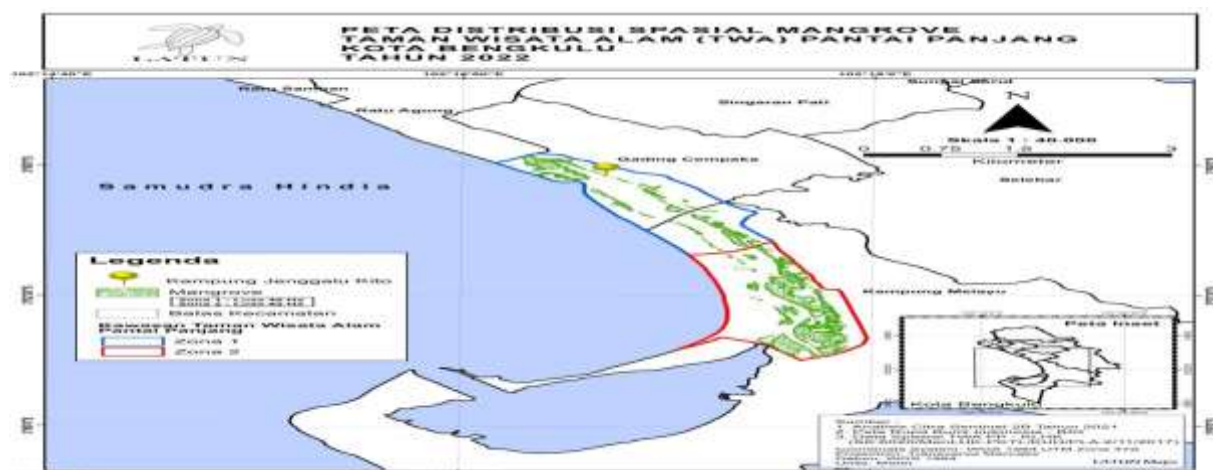


Figure 2. Spatial Distribution Map of Mangroves in TWA Pantai Panjang, Bengkulu City

Source: (TWA Mangrove, n.d.)

RESULTS

Mangrove Ecosystem Potential in Jenggalu Kito Village

The potential analysis of the mangrove ecosystem focuses on four key aspects: direct benefits, indirect benefits, option benefits, and existence benefits.

Direct benefits derived from the mangrove ecosystem in Jenggalu Kito Village include fish, crabs, shrimp, and mollusks. The total economic value of fish is IDR 256,335,004/month, crabs provide IDR 47,528,750/month, shrimp contribute IDR 114,125,000/month, and mollusks provide IDR 104,266,667/month. These values indicate the significant economic contribution of the mangrove ecosystem to the local economy (Yáñez-Arancibia & Day, 2018).

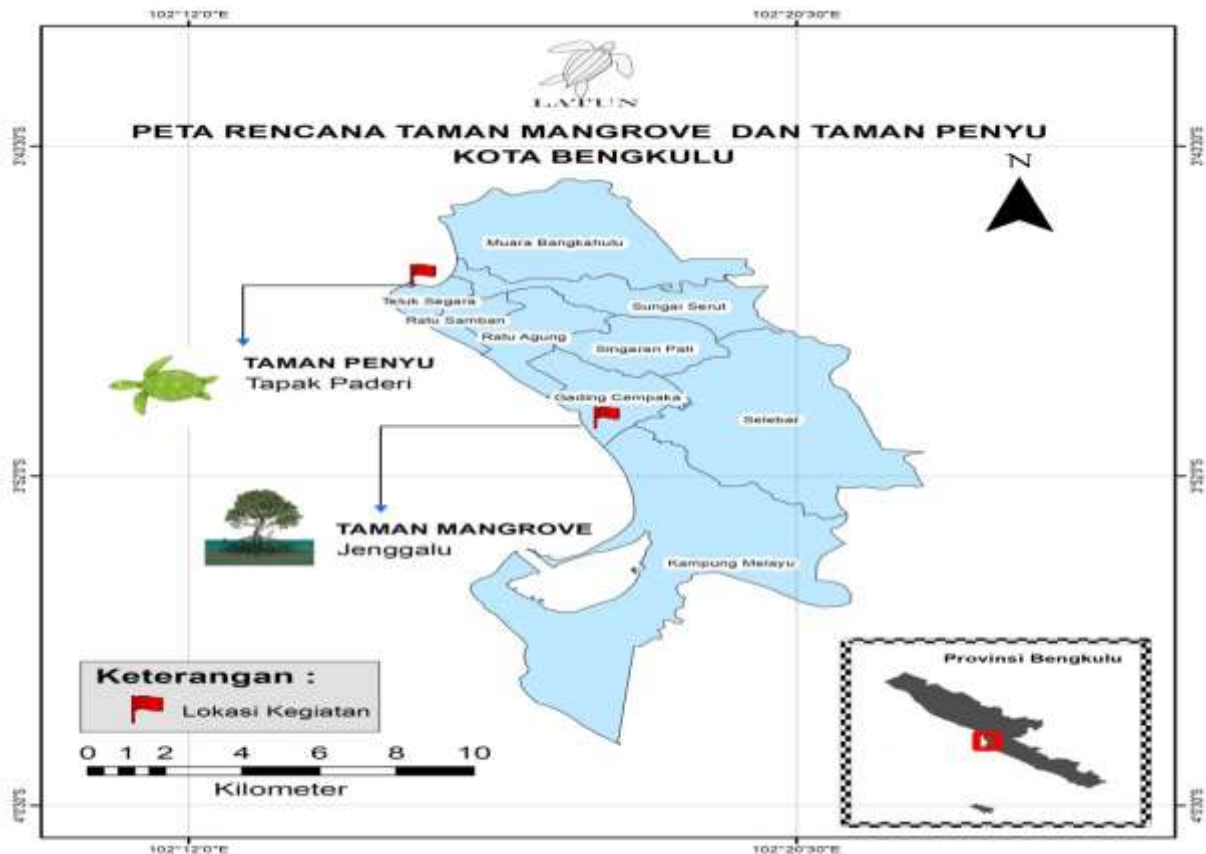


Figure 3. Mangrove and Turtle Park Area Map in Jenggalu Kito Village

Source: Mangrove and Turtle Park, 2021

Direct Benefits

The direct benefits of the mangrove ecosystem in Jenggalu Kito Village, Gading Cempaka District, Bengkulu City, are the sum of the four categories of direct use benefits. These are summarized in the following table:

Table 1. Total direct benefits of the mangrove ecosystem in Jenggalu Kito Village, Gading Cempaka District, Bengkulu City.

No	Type of Direct Benefit	Valuation (IDR/Month)	Percentage (%)
1.	Fish Direct Benefit	256,335,004	49
2.	Crab Direct Benefit	47,528,750	9
3.	Shrimp Direct Benefit	114.125.000	22
4.	Mollusk Direct Benefit	104.266.667	20
Total		521.925.421	100
Average		26.096.271	25

Source: Processed Data, 2023

Table 1 shows that the total direct benefit from fish is IDR 256,335,004/month, from crabs is IDR 47,528,750/month, from shrimp is IDR 114,125,000/month, and from mollusks is IDR 104,266,667/month. The total value of direct benefits from the Mangrove Ecosystem in Jenggalu Kito Village is IDR 521,925,421/month, with an average of IDR 26,096,271/month. In comparison, a study by Carin et al. (2018) in Tongke-tongke Village found that 563 fishermen generated direct benefits from fish catches of IDR 106,680,000/year, with a total benefit of IDR 3,003,042,000/year.

Indirect Benefits

a) Mangrove Ecosystem Services as Nursery Ground

The economic value of the mangrove ecosystem as a nursery ground, feeding ground, and spawning ground is calculated using the formula:

Area (ha) × US\$ 142.64 × Rupiah exchange rate

For Jenggalu Kito Village, the calculation is:

6 hectares × 142.64 × IDR 15,260 = IDR 2,176,686.4/year, or IDR 181,390/month.

The indirect economic value of the mangrove ecosystem as a nursery ground, feeding ground, and spawning ground for fish and other marine organisms is IDR 181,390/month. In a similar study by Widiyanto et al. (2013), the net economic value of these services was IDR 372,985,770/year (Alongi, 2020).



Figure 4. Mangrove Planting

Source: Mangrove Planting, n.d.

b) Erosion Control and Pond Protection

The cost of building river embankments requires materials such as stone, cement, sand, and steel reinforcement. The estimated total cost of constructing embankments in Jenggalu Kito Village, Gading Cempaka District, Bengkulu City, is IDR 1,764,000. With an average embankment height of 3 meters, width of 0.5 meters, and length of 250,000 meters, and a durability of 10 years, the total cost is IDR 441,000,000/year. When divided into monthly costs, the result is IDR 3,675,000/month. Therefore, the total indirect benefit value is IDR 181,390 (nursery ground) + IDR 3,675,000 (erosion control) = IDR 3,856,390/month (Barbier, 2016).

Table 2. Cost of building river embankments requires materials

Cost Type	Quantity	Unit Price (IDR)	Total (IDR)
Stone	1 Cubic Meters	240.000	240.000
Cement	6 Sacks	54.000	324.000
Sand	2 Cubic Meters	190.000	380.000
Labour	Contract	150.000/m ²	150.000
Reinforced Steel	10 Pieces	67.000	670.000
TOTAL			1.764.000
Durability	10 Years		17.640.000
Area (Ha)	25.000 m²		441.000.000

Source: Processed Data, 2023

The Indirect Benefit Value of embankment construction is calculated as follows:

= Land area × cost per 1 meter

= 250,000 meters × IDR 1,764,000

= IDR 441,000,000/year

When divided into a monthly rate, it amounts to IDR 3,675,000/month. Therefore, the total Indirect Benefit Value is IDR 181,390 + IDR 3,675,000 = IDR 3,856,390/month.



Figure 5. Coastal Erosion Control Embankment

Option Benefits

Table 3 Total Option Benefits from Mangrove Products

Mangrove Revenue	Tea	Mangrove Seed Revenue	Mangrove Chip Revenue	Total Revenue (IDR)
378.167		735.000	40,000	1.153.167

Source: Processed Data, 2023

Total option benefit from the production of mangrove tea, seeds, and chips is IDR 1,153,167/month. These products contribute to the community's income and highlight the economic potential of sustainable mangrove resource utilization (Yáñez-Arancibia & Day, 2018).

Existence Benefit

Existence Benefit of mangrove benefits is derived from the community's willingness to pay for the preservation of the mangrove ecosystem in their area. This value reflects how much people are willing to contribute to ensuring the continued existence and protection of mangrove forests. Existence Benefit of the mangrove ecosystem is presented in Table 4.4 below:

Table 4 Existence Benefit of Mangrove

No	Willingness to Pay/Year (IDR)	Number of Respondents	Percentage (%)
1.	10.000 – 40.000 (Low)	5	25.0
2.	40.001 – 70.000 (Medium)	12	60
3.	70.001 – 100.000 (High)	3	0.1
Jumlah		20	100.0

Source: Processed Data, 2023

This table highlights the Existence Value of mangrove ecosystems based on the willingness of local residents to pay for the continued preservation of the mangrove forests. The majority of respondents (60%) are willing to pay between IDR 40,001 – 70,000 annually, showing a moderate level of commitment to mangrove preservation. A smaller percentage (25%) are willing to pay a lower amount, while 15% are willing to pay a higher amount of IDR 70,001 – 100,000 annually. This distribution provides insight into the community's valuation of the mangrove ecosystem's environmental and protective functions.

DISCUSSION

The Total Option Value of the mangrove ecosystem in Kampung Jenggalu Kito is estimated at IDR 1,153,167 per month, with an average of IDR 57,658 per month. This indicates that the ecosystem presents a promising prospect if properly managed and sustained. In comparison, research by Tahang & Amir (2018) uses a method of benefit transfer to estimate the option value by evaluating biodiversity benefits. The biodiversity benefit is estimated at USD 15 per hectare per year, with a total mangrove ecosystem area of 758 hectares, resulting in a

biodiversity value of IDR 154,063,500 per year. This comparison highlights the potential economic contribution of mangrove biodiversity to local communities .

Based on Table 4.4, the range of willingness to pay (WTP) for mangrove preservation is about IDR 1,130,000 per month. The table reveals that the community's willingness to pay for preserving the mangrove ecosystem is still relatively low. Many believe that since they are already involved in planting, breeding, and maintaining the mangroves, there is no need to pay additional costs. This perspective is in line with research by Ekonomi et al. (2019), which found that the WTP for mangrove ecosystem preservation in Dumai ranged from IDR 10,000 to IDR 50,000. The median WTP was IDR 20,000 per year, with a total estimated WTP of IDR 223,360,000 per year for the entire population of Bandar Bakau .

The total option value contained within the mangrove ecosystem in Jenggalu Kito Village is IDR 1,153,167 per month, with an average of IDR 57,658 per month. This signifies that the value of the mangrove ecosystem in Jenggalu Kito Village has a promising outlook if continuously managed and monitored. According to Tahang & Amir (2018), calculating option value can be achieved by estimating benefits from other regions (where resources are available) and transferring those benefits to obtain a rough estimate of environmental advantages. This method is also aligned with the approach of evaluating the biodiversity benefits within mangrove areas. For instance, the total biodiversity value is obtained by multiplying the benefit value of US\$15 per hectare per year with the exchange rate of IDR 13,550, resulting in IDR 203,250 per hectare. This value is then multiplied by the total area of the current mangrove forest ecosystem, which is 758 hectares, giving a total biodiversity value of IDR 154,063,500 per year (Simau et al., 2020).

Based on Table 4.4, the range is IDR 30,000, indicating that the existence value, assumed through the community's willingness to pay (WTP) for the preservation of the mangrove ecosystem, amounts to IDR 1,130,000 per month. From this table, it is evident that the community's willingness to pay for the preservation of the mangrove ecosystem is relatively low. Many believe they do not need to make payments since they have already contributed to mangrove planting, nursery, and ecosystem protection efforts.

In comparison, Ekonomi et al. (2019) studied the WTP for the biota habitat within the Dumai mangrove ecosystem, revealing that the WTP value for preserving the ecosystem ranged between IDR 10,000 and IDR 50,000. Fifteen respondents were willing to pay IDR 10,000, six respondents were willing to pay IDR 20,000, four respondents paid IDR 30,000, two respondents paid IDR 40,000, and three respondents paid IDR 50,000. The annual WTP value was derived from multiplying the WTP amount by the number of respondents willing to pay. This resulted in a total annual WTP value of IDR 620,000. The median WTP, representing the midpoint value of the annual WTP from respondents willing to pay, was IDR 20,000. The total annual WTP for preserving the Dumai mangrove ecosystem, based on the estimated population of Bandar Bakau (11,168 residents), amounted to IDR 223,360,000 per year (Widiastuti et al., 2020; Kumar et al., 2019).

The diagram shows that the Jenggalu Kito Village community predominantly utilizes the direct benefits of the mangrove ecosystem compared to other benefit types. This observation contrasts with the findings of Khairunisa et al. (2018), where the surrounding community primarily took advantage of indirect benefits in their study.

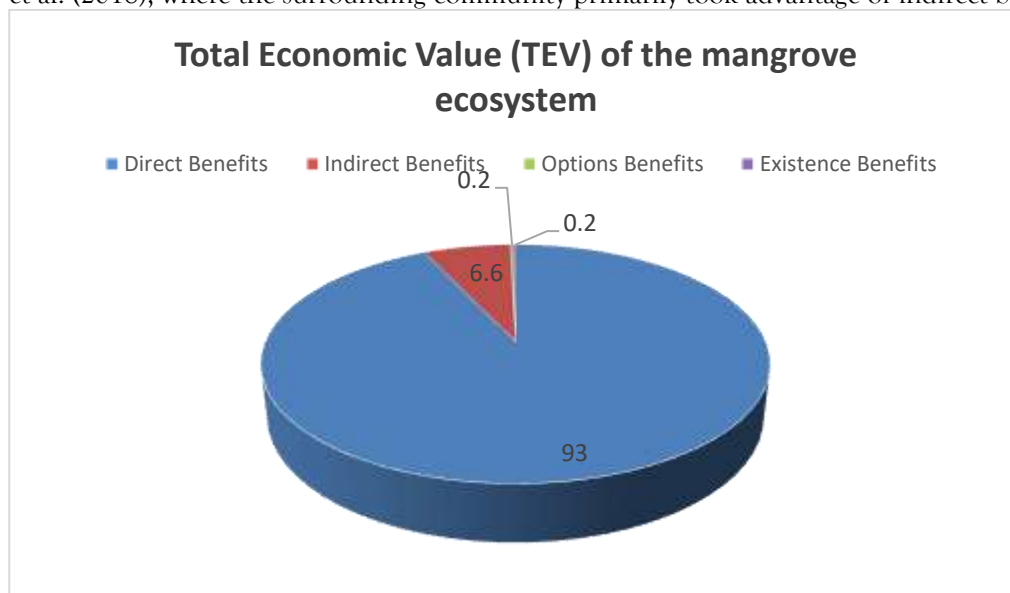


Figure 1. Total Economic Value (TEV) of the ecosystem.

The diagram below illustrates the total economic value of the mangrove ecosystem. It shows that the community of Kampung Jenggalu Kito primarily benefits from direct use values, a trend opposite to research by Khairunisa et al. (2018), where communities benefit more from indirect use values .

Total Economic Value of the Mangrove Forest in Kampung Jenggalu Kito

Largest contributor to the total economic value of the mangrove ecosystem in Kampung Jenggalu Kito is direct use values, accounting for 93%. Indirect use values contribute 6.6%, while option values and existence values each contribute 0.2% to the total value, amounting to IDR 561,139,978 per month. Similar studies by Simau et al. (2020) indicated that the highest contribution in their mangrove analysis came from indirect use values, amounting to IDR 2.15 billion, with direct use values contributing IDR 523.29 million. The difference in findings between these studies emphasizes the varying economic potential of mangrove ecosystems based on location and management strategies .

This study provides a comprehensive valuation of the mangrove ecosystem in Kampung Jenggalu Kito, which has not been previously assessed. The analysis reveals the dominance of direct benefits, such as fish, shrimp, and crab harvests, contributing significantly to the local economy. The novelty lies in highlighting the economic potential of the mangroves and offering comparative insights with other regions. These findings can support decision-making processes for sustainable management and the protection of this valuable ecosystem .

Table 4.5 Total Economic Value (TEV) of the mangrove ecosystem in Jenggalu Kito Village

Benefit Type	Economic Value (IDR/month)	Ecosystem (IDR/Month)	Percentage (%)
Direct Benefit	a). Direct benefits from fish species b). Direct benefits from shrimp species c). Direct benefits from crabs d). Direct benefits from clams	521.925.421	93.0
Indirect Benefit	a). Barrier against sea water intrusion b). Spawning grounds	36.931.390	6.6
Options Benefit	a). Sale of tea b). Sale of mangrove seedlings c). Sale of mangrove chips	1.153.167	0.2
Existence Benefit	a). WTP (Willingness to Pay) for the preservation of the mangrove ecosystem	1,130,000	0.2
Total Economic Value		561,139,978	100
Average		28.056.998	25

Source: Processed Data, 2023

Indicate that the total economic value of the mangrove ecosystem in Jenggalu Kito Village, Gading Cempaka District, Bengkulu City, is IDR 561,139,978 per month. The direct benefits of the mangrove ecosystem are valued at IDR 521,925,421 per year, indirect benefits at IDR 36,931,390 per month, and existence benefits at IDR 1,130,000 per year. This is consistent with the findings of Valuation et al. (n.d.), who stated that the total economic value consists of a combination of direct, indirect, option, and existence benefits. Their study showed a total economic value of IDR 3,504,487,581 per hectare per year, with the largest proportion coming from direct benefits (79.48%), followed by indirect benefits (0.40%), option benefits (0.10%), and existence benefits (0.001%).

CONCLUSION

Research conducted in Kampung Jenggalu Kito, Gading Cempaka District, Bengkulu City, indicates that the Direct Use Value from the utilization of the mangrove forest in Kampung Jenggalu Kito is IDR 521,925,421/month. The Indirect Use Value is IDR 46,276,686/year, the Option Value is IDR 1,153,167/month, and the Existence Value is IDR 1,130,000/month.

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