



Economic valuation of Pade'an Hamlet mangrove forest, Jarangan Village, Rejoso District, Pasuruan Regency, Indonesia

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ABSTRACT

The mangrove ecosystem has enormous benefits for the community, especially for people who live on the coast, including the mangroves in the Pade'an Hamlet, Jarangan Village, Rejoso District, Pasuruan Regency. This study aims to determine the economic value of mangrove forest in Pade'an Hamlet area using total economic value approach. This study used descriptive analysis to explain the activity of utilizing the natural resources of the mangrove ecosystem and quantitative analysis to calculate the total economic value of the mangrove ecosystem. The economic value of mangrove forests in the Pade'an Hamlet area per year is IDR 10,092,881,400.00. The total economic value obtained from the direct-use value (utilization of the fisheries sector) amounted to IDR 7,593,550,000.00/year, indirect-use value (abrasion restraints) amounted to IDR 2,335,952,000.00/year, option value (biodiversity) amounted to IDR 13,379,400.00/year, and existence value calculated from the willingness to pay of the local community is IDR 150,000,000.00/year. The magnitude of the total economic value of the mangrove ecosystem in Pade'an Hamlet area indicates that the mangrove ecosystem provides huge of essential benefits to the community.

Keywords: total economic value, mangrove ecosystem, valuation

INTRODUCTION

Mangrove is an area where its growth is influenced by the tides of sea water [1]. Mangrove has a function as a barrier to coastal abrasion and as a habitat for a lot of marine organisms such as fishes, shrimps, and many types of birds [2]. Mangrove also has function as primary producers who support and are able to maintain ecosystem stability, especially in areas around the coast. The benefits of mangroves are very large where the greater the benefits provided by the greater the exploitation carried out in the mangrove area [3,4].

With the many benefits that can be taken from mangroves, we can apply economic valuations to existing mangroves so that it can be calculated how much the value of mangroves can be utilized by the surrounding community. The economic valuation of environmental services can be used as a tool to increase public appreciation and awareness of the environment. Economic valuation of environmental services can be defined as an effort to provide quantitative value to goods and services produced by natural resources and the environment both on market value and non-market value. The economic valuation of environmental services aims to advance the linkage between natural resource conservation and economic development [5].

The definition of economic valuation is an economic tool that uses certain assessment techniques to provide quantitative value to the results of natural resources, be it in the form of goods or services [6]. The purpose of conducting economic valuation of natural resources is to find out the comparison between benefits

and losses (costs) produced so that it is hoped that users of natural resources and the environment can decide policies in resource and environmental management as well as possible to minimize the occurrence of losses and even environmental damage [7].

Pasuruan is one of the cities located in East Java Province which has a mangrove ecotourism area that is rarely visited by tourists, namely mangrove ecosystem in Pade'an Hamlet, Jarangan Village. This occurs because of the lack of promotion related to this mangrove area or the distance that is an obstacle for tourists. The community and the local government should be able to use this mangrove area to improve the living of the surrounding community, especially in the economic sector. Therefore it is important to implement policies and also the management of this mangrove area as a driver of community economic growth and also the right handling in managing natural resources [8]. This study aims to determine the economic value of the mangrove ecosystem in Pade'an Hamlet, Jarangan Village, Pasuruan Regency.

METHODS

Study Site

This study was conducted in Pade'an Hamlet, Jarangan Village (Figure-1). Jarangan is one of the villages located in Pasuruan Regency and is located at the northern end or directly adjacent to the northern coastal area of the Madura Strait. This village is located in Pasuruan Regency precisely in Rejoso District, about 1 km from the District city and 5 km from Pasuruan city. This area is located between 7°40'20" S 7°36'50" S and

112°55'50" E 112°58'10" E. This area has three hamlets, namely Jarangan, Pade'an and Bandaran Hamlet with a total of 3 *Rukun Warga* and 18 *Rukun Tetangga* (*Rukun Tetangga* is the division of villages in Indonesia under *Rukun Warga*) with a total of 300 head of households. It has an area of about 643,702 ha. More specifically, the mangrove area in the Pade'an Hamlet currently about 60 ha.

Pade'an Hamlet located on the coast, and most of the land is in the form of ponds with the livelihood of cultivation and home industries (production of shrimp pastes and crackers). The populations consist of 1,303 males and 1,269 females, of which 41 of the total 1,246 inhabitants are pre-prosperous, and prosperous families (1:360).

Data Collection

The data was collected from observations, market surveys, and in-depth interviews with questions that have been prepared and required for analysis (Figure-2). The selection of respondents was done by purposive sampling method. The process of interviewing respondents in this study was obtained on the basis of recommendations from key persons with the consideration that these respondents could provide data or information that supports and is in accordance with the study.

Data Analysis

Data were analyzed descriptively and quantitatively. Descriptive data analysis is used to explain natural resource utilization activities or the pattern of utilization of the existing mangrove ecosystem in the study area. Quantitative data analysis is used to calculate the total economic value of mangrove ecosystems in the study area.



Figure-2. Interview with fish farmers at study site

The calculation of economic valuation is carried out by calculating the total economic value by summing the use value with the non-use value. Use value includes direct use value, indirect use value, and option value. Meanwhile, non-use value includes existence value and bequest value. The calculation of total economic value is shown in Equation (1)-(3) [9].

$$TEV = UV + NUV \quad (1)$$

$$UV = DUV + IUV \quad (2)$$

$$NUV = OV + EV + BV \quad (3)$$

where *TEV* is Total Economic Value, *UV* is Use Value, *NUV* is Non-Use Value, *DUV* is Direct Use Value, *IUV* is Indirect Use Value, *OV* is Option Value, *EV* is Existence Value, and *BV* is Bequest Value.

RESULTS AND DISCUSSIONS

Use Value

Use value in this study consists of direct use value and indirect use value. Direct use value is the value obtained from the direct use of the mangrove ecosystem in Pade'an Hamlet by the local community. The direct use of the mangrove ecosystem carried out by the community of Pade'an Hamlet include the utilization of milkfish, crabs, and shrimp. In addition to the direct use value, there is also an indirect use value for the mangrove ecosystem in Pade'an Hamlet, including the function value of mangroves as a barrier to beach abrasion.

Direct Use Value

The assessment of the value of the direct use of the mangrove ecosystem is approached using a market value and productivity approach to community utilization. The direct benefit values found in Pade'an Hamlet are fisheries productivity include the use of *jerbung* shrimp, milkfish, and crabs around the mangrove ecosystem area.



Figure-1. Map of study area

Table-1. The value of the direct use of the mangrove ecosystem in Pade'an Hamlet

Commo-dities	Average production /yr (kg)	Price/kg (IDR)	Gross income (IDR)	Cost of production/yr (IDR)	Net income (IDR)	Number of fish farmers	Direct use value (IDR)	
Shrimp	403	40,000	16,120,000	608,000	15,512,000	150	2,326,800,000	
Milkfish	3,033	14,000	42,462,000	9,000,000	33,462,000	150	5,019,300,000	
Crab	693	40,000	27,720,000	2,975,000	24,745,000	10	247,450,000	
Total								7,593,550,000

Jerbung shrimps (*Penaeus merguensis*) and crabs have a high economic value so that it is in great demand by the community around the mangroves of Pade'an Hamlet. The shrimp is obtained through a pond which in the afternoon the fish farmer will set a trap (*bubu*) and in the morning it will be lifted. The results obtained by each pond will be different from other ponds, depending on the healthy of the ponds. The crabs are caught wildly in ponds or also in mangrove forests using *bubu*.

The economic value of milkfish utilization has the highest percentage (66%) compared to other types of direct utilization, namely IDR 5,019,300,000.00/year (Table-1). This value is obtained from average milkfish production of 3,033 kg/year, with a market price of IDR 14,000.00/kg, and operational costs incurred by fish farmer amounting to IDR 9,000,000.00/year. The costs needed on milkfish cultivating using pond media in a year (3-4 times of harvest) are as follows:

- Milkfish feed cost vary between IDR 4,000,000.00 to IDR 5,000,000.00
- Fertilizer cost vary between IDR 500,000.00 to IDR 600,000.00
- Farm repair cost: ± IDR 1,000,000.00
- Labor cost per harvest : ± IDR 500,000.00
- Fuel cost: ± IDR 600,000.00
- Tax vary between IDR 300,000.00 to IDR 400,000.00

The costs needed for milkfish farming can be different for each fish farmer. For example, the number of fish seeds to be cultivated which adjusts to the size of the pond because it is related to the ability to live of fish in the water. The fish farmer will also see the season and the weather if it is has good potential in the future, the farmer will increase the number of seedlings.

Furthermore, for the *jerbung* shrimp catch, a value of IDR 2,326,800,000.00 (31%) was obtained with an average catch per year of 403 kg and a market price of IDR 40,000.00/kg. Crab with an average catch of 693 kg/year, a market selling price of IDR 40,000.00/kg, and operational costs incurred by fish farmer amounting to IDR 2,975,000.00 obtained an economic value of IDR 247,450,000.00/year (3%).

The costs needed on crabs catching using *bubu* are as follows:

- Cost of making a *bubu*: IDR 30,000.00
- Crab feed cost per kg: IDR 15,000.00
- Transport cost: IDR 10,000.00
- Repair cost: IDR 45,000.00 – 60,000.00

Every crab fisher has a different incurred cost, depend on the number of *bubu* mounted. Along with the increase in the number mounted *bubu*, at least *bubu* mounted can be up to 20-30, will also effect on the amount of feed to be

purchased. The feed purchased can be up to 3-4 kg every 20 *bubu*. The transport cost of each person is also different depending on the distance of the person's house to the catch location. Repair costs is the cost of repairing a damaged *bubu*, for example, *bubu* net that is damaged because it is broken by wood or iron, or *bubu* frame that is broken because it has often been exposed to salt water.

The total value of the direct benefits of mangrove ecosystem, as fisheries productivity, in Pade'an Hamlet is IDR 7,593,550,000.00/year or IDR 126,559,166.00/ha/year (mangrove area of 60 ha). The calculation of the economic value of fisheries productivity for each region has different results. This is evidenced by previous study [10] in mangrove of Margasari Village, Labuhan Maringgai, East Lampung. The type of catch in the form of shrimp and crab obtained an economic value of IDR 925,114.00/ha/year, while in mangrove of Pabean Udik Hamlet with catches of shrimp, clams, mullets, and crabs of IDR 32,654,428.00/ha/year [11]. This difference can be caused by the number of catches per year, market prices, and the condition of the mangrove ecosystem in each area.

Indirect Use Value

Environmental services are a function of ecosystem services, both natural and man-made, which provide indirect benefits in improving environmental quality for the welfare of the people in Pade'an Hamlet. The indirect benefits of the mangrove ecosystem in Pade'an Hamlet are preventing abrasion and retaining sea waves. The calculation of the value of this benefit is carried out using the replacement cost approach by calculating the costs required to build an embankment.

The value of mangroves as a barrier to abrasion and sea waves is obtained from the cost of constructing a building to resist abrasion and sea waves (embankment) which is IDR 5,839,880.00/meter [12], while the length of the coastline in Pade'an Hamlet is 2,000 meters. Based on these data, it can be calculated that the value of the benefits of mangrove forests as a barrier to abrasion and sea waves in Pade'an Village, amounting to IDR 2,335,952,000.00 (Table-2).

Calculations were also made using the cost of making bamboo embankments to resist abrasion. This is because the abrasion barrier made of bamboo material already exists at the study area. Besides that, abrasion barrier made of bamboo is more friendly to the environment compared to concrete material. The costs needed to make an abrasion barrier from bamboo are as follows.

- Cost of bamboo per stick: IDR 50,000.00
- Cost of labor per day: IDR 75,000.00
- Transportation cost: IDR 1,000,000.00

In one meter of abrasion resistance work with bamboo materials, approximately 8-10 bamboo sticks are needed. With approximately 100 meters of work per day, so that the abrasion barrier work can be completed in approximately 20 days. Thus for the work per meter of bamboo abrasion resistance it can be assumed to cost around IDR 575,000.00.

Based on the results of the interviews, the lifetime of the bamboo abrasion barrier was three years, so the indirect benefit was obtained from mangrove forests in Pade'an Hamlet as an abrasion barrier equivalent to IDR 383,333,333.00 per year (Table-3). So that the calculation is more preventive, the indirect value used in this study is IDR 2,335,952,000.00 from concrete embankment construction as a barrier to beach abrasion.

Table-2. Indirect use value of Pade'an Hamlet mangrove ecosystem from concrete embankment construction

Description	Value
Embankment construction costs (IDR/m)	5,839,880
Coastline length (m)	2,000
Lifetime (year)	5
Benefit value (IDR/year)	2,335,952,000

Table-3. Indirect use value of Pade'an Hamlet mangrove ecosystem from bamboo embankment construction

Description	Value
Bamboo embankment construction costs (IDR/m)	575,000
Coastline length (m)	2,000
Lifetime (year)	3
Benefit value (IDR/year)	383,333,333

Non-Use Value

Non-use value, or intrinsic value, is the value given to natural resources and the environment on the basis of their existence, even if they are not consumed directly. The value given is actually difficult to measure and analyze because it is based more on preference for the environment than direct use. This value is related to the positive willingness to pay value if someone does not intend to use it.

Option Value

The option value assessed in this study is the value of flora and fauna in the mangrove forest ecosystem in Pade'an Hamlet. In other word, option value assessment refers to the biodiversity value of the mangrove ecosystem. The biodiversity value used is the result of research in Bintuni Bay, West Irian, which is US\$ 15/ha/year [13]. The research conducted in Bintuni Bay in 1992, so that the calculation results were more up to date, a compound was carried out in 2022.

Total value of the biodiversity benefit is obtained by multiplying the value of the benefit, which is US\$ 15 per ha per year, with the rupiah exchange rate to the US dollar which is IDR 14,866.00 (in 2022), so that it can be valued at IDR 222,990.00 per ha per year. The total area of mangrove forest in Pade'an Hamlet is 60 ha, so if multiplied by the total area of the mangrove forest ecosystem in the area, the biodiversity benefit of mangrove forests in the area is IDR 13,379,400.00 per year as shown in Table-4.

Existence Value

The existence value can be interpreted as the value of a person's concern for natural resources [3]. The results of the interview conducted obtained the total willingness to pay (WTP) value given by respondents to the existence of mangroves as an existence value of IDR 2,500,000.00/ha/year as shown in Table-5.

Table-4. Biodiversity value

Description	Value
Biodiversity value (US\$/ha)	15
Biodiversity value (IDR/ha)	222,990
Mangrove area (ha)	60
Biodiversity as an option value (IDR/year)	13,379,400

Table-5. WTP of existence of mangroves in Pade'an Hamlet area

Description	Value
Minimum WTP value (IDR/year)	300,000
Maximum WTP value (IDR/year)	720,000
Average WTP value (IDR/year)	500,000
Head of households	300
Mangrove area (ha)	60
Total WTP value (IDR/year)	150,000,000
Total WTP value (IDR/ha/year)	2,500,000

The respondents who were sampled were willing to pay a nominal value between IDR 25,000.00 up to IDR 60,000.00 per month or IDR 300,000.00 up to IDR 720,000.00 per year, with an average WTP value of IDR500,000.00 per year. The total value of WTP per year is the result of the multiplication between the average value of WTP per year and the number of head of households in Pade'an Hamlet. With the total mangrove area of 60 ha, the WTP value of IDR 2,500,000.00/ha/year is obtained.

The WTP value in each region varies depending on the availability of payments issued by the local community. The greater the availability of payments issued can be used as an indication that their awareness and concern for the sustainability of the mangrove ecosystem are increasing. The findings of [14] regarding the WTP value of the mangrove ecosystem in Blanakan Bay, Subang amounting to IDR 26,564.00/ha/year, with a mangrove area of 782.34 ha, showed that the education level of the respondents influences the existence value.

Another factor that is suspected of differentiating the value of the WTP is the lack of knowledge regarding the benefits of the existence of mangrove ecosystems, so that respondents tend not to care about the value of the existence of mangrove ecosystems and this affects the value of the WTP given [15].

Total Economic Value

The total economic value of the mangrove forest ecosystem in Pade'an Hamlet is the sum of the use value and non-use value. The use value consists of direct use value, indirect use value, and option value, while the non-use value consists of existence value (Table-6). The total economic value of the mangrove ecosystem in Pade'an

Hamlet is IDR 10,092,881,400.00/year. From all the components of the total economic value, the value of direct use value has the greatest value compared to other values.

Table-6. Total economic value of mangrove forest in Pade'an Hamlet area

Description	Value (IDR/year)
Use value	
Direct use value	7,593,550,000
Indirect use value	2,335,952,000
Non-use value	
Option value	13,379,400
Existence value	150,000,000
Total Economic Value	10,092,881,400

The total economic value of mangrove forest in Pade'an Hamlet area indicates that the mangrove ecosystem at the study site has greater socio-economic value then followed by the value of ecological benefits. The same thing was also found in the research of [11], while the research of [10] and [14] obtained the opposite result, namely the economic value of the ecological benefits is greater than the socio-economic benefits.

The magnitude of the total economic value of this mangrove forest shows that the mangrove ecosystem in Pade'an Hamlet has high benefits and plays an important role in the lives of the people around the mangrove ecosystem area, especially people who work in the fisheries sector, such as fisher and pond farmers. The total economic value of mangrove ecosystems in Pade'an Hamlet in this study does not yet reflect the overall benefits of mangrove ecosystems, because other benefits such as utilization of mangroves for food and drinks product and forestry sector have not been utilized by the community optimally. Mangrove ecosystems have the importance function for society and the environment, thus preferably the government, society, and the private sector plays an active role in protecting and preserving the mangrove ecosystem in Pade'an Hamlet.

CONCLUSIONS

The economic value of mangrove forests in the Pade'an Hamlet area per year is IDR 10,092,881,400.00 or equivalent to IDR 168,214,690.00/ha/year. The total economic value consists of direct use value include benefits in the field of fisheries of IDR 7,593,550,000.00, indirect use value as measured by the value of abrasion restraint development of IDR 2,335,952,000.00, option value measured by the biodiversity level benefit of IDR 13,379,400.00, and existence value calculated from the willingness to pay of the local community is IDR 150,000,000.00.

The results of the economic valuation above illustrate that the ecological and socio-economic benefits of the mangrove ecosystem in Pade'an Hamlet are quite large, so that the role of the government, the community and related institutions is needed in the management and utilization of the mangrove ecosystem considering the magnitude of the benefits values may change in the future.

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