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Management of Protected Mangrove Forest Based Benefit Value in Batu Ampar District, West Kalimantan, Indonesia

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Abstract

Protected mangrove forest needs to be managed prudently in accordance with the purpose of sustainable development. To determine the potential and utilization of protected mangrove forests carried out by local communities in the District of Batu Ampar, it is necessary to know the value of protected mangrove forest beneficiaries utilized by them. The results showed that the dominant mangrove tree species are *Rhizophora apiculata*, *Bruguiera gymnorhiza*, *Sonneratia alba*, and *Avicennia alba*.

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Total economic value of mangrove ecosystem at Batu Ampar was amounted to 35,223,474,120 per year with 5,198.52 ha of mangrove area, consisting of existing value Rp 27,386,581,500 per year (77.75%); indirect value Rp 3,869,442,410 per year (10.98%); direct use value Rp 2,929,650,000 per year (8.32%); and option value Rp 1,037,800,210 per year (2.95%). Besides the good perception of community to the function of mangrove, mangrove ecosystem utilization was sustainability because still under potential value of mangrove ecosystem. To guarantee the sustainability of mangrove utilization by local community in Batu Ampar, it was recommended to divide zones of utilization are into 2 zones, i.e. protection zone and limited utilization zone.

Keywords: Mangrove forest protected; value benefit; management.

1. Introduction

Protected mangrove forest have the main function as a balancing agent of coastal ecosystem and producer of the needs of humans and other organisms [1]. Mangrove forests produce goods and provide services. They produce timber and as a spawning ground, nursery ground, and feeding ground for fish and other marine lifes. They also serve as a barrier of sea waves and the intrusion of sea water into the ground and able to decompose the mangrove garbage become a food source for marine life as one indicator to determine the productivity of the waters [2]. Of the approximately 137,760 km^2 of mangrove forests in 118 countries and territories, approximately 22.6 % are in Indonesia [3]. While the mangrove areas in Indonesia based on data from Geospatial Information Agency in 2009 was 3,244,018.46 ha [4]. One of the areas in Indonesia which has a fairly extensive mangrove forests are in Kubu Raya, West Kalimantan Province. Based on data from the Plantation, Forestry and Mining Agency in 2014, mangrove forest area in Kubu Raya Regency is approximately 99,532.90 ha, one of which is a protected mangrove forest in the District of Batu Ampar with area is 33,731.66 ha [5]. They also pointed out that from this area , the most extensive mangrove forest damage in Batu Ampar District, where an area of 2,265 ha in heavily damaged, 561 ha in minor damage and 18,787 ha in low productivity. Changes and damage to ecosystems protected mangrove forests due to human activities need to be studied to get the concept of protected mangrove forest use management in a sustainable manner. Therefore, it is necessary to identify mangrove species found in forests protected mangrove, potential and uses of protected mangrove forests that has been done by the local community, value the economic benefits of protected forest mangrove and how sustainable management of protected mangrove forest in the District of Batu Ampar. This study aims to: (1) identify the potential and the type of vegetation in the mangrove protected mangrove forest in Batu Ampar; (2) identify the types and patterns of protected mangrove forest use by local communities; (3) analyze the value of the economic benefits protected mangrove forest in Batu Ampar; and (4) formulating the sustainable management of protected mangrove forest based benefits value in Batu Ampar.

2. Methodology

2.1. Location and time

The research was conducted in the District of Batu Ampar, Kubu Raya Regency of West Kalimantan Province, from March to September 2015.

2.2. Data collection

The object of research is protected mangrove forest ecosystems and the surrounding community as well as government agencies. The sampling method in this research is purposive sampling techniques. Samples of the community consist of 50 respondents. Respondents are people who use natural resources from the protected mangrove forests. The data collection also conducted by interviews with forestry agencies and other relevant agencies. Making procedures and data collection in this study can be seen in Table 1.

Table 1: Procedures for data collection and research

Type of Data	Atribute/Variable	Method	Usage
A. Primary Data	Potential vegetation (type name; the number of individuals of each species; diameter - total height)	Vegetation analysis	Knowing the species composition and abundance of mangrove
	Values Economic benefits that include : - The value of direct benefits - The value of indirect benefits - The value of the benefits of option - The value of the benefits of existence	Interview	1. Knowing the variety or varieties of mangrove forest use 2. Knowing the economic value of mangroves
	Public perception of the existence of protected mangrove forest	Interview	Desire Utilization protected mangrove forest
B. Secondary Data	Administrative and geographical layout ; extensive research sites ; location map; level of education , socio-economic circumstances ; the physical condition of the field	Document / report	Supporting data

2.3. Data analysis

Analysis of ecological conditions of mangrove forests can be known by using indicators of species density, frequency, coverage area, and Important Value Index (IVI) of each species [6]. The IVI value being estimated by three calculations, i.e. the species density, frequency, and coverage area. Species density (*Di*) is the number of species-i stands in an area (square area which is 10 m x 10 m). The equation to estimate the species density is:

$$Di = Ni / A \qquad (1)$$

where is: *Di* = the density of the species (*Rhizophora*, *Avicennia*, *Bruguiera*, and *Xylocarpus*); *Ni* = the total amount of the species; *A* = total area of sampling area (square of 10 m x 10 m). The value of this species density then is used to find the relative density of species (*RDi*).

Relative density is the ratio between the number of species (*ni*) and the total amount of the all species (Σn), with the equation:

$$RDi = (ni / \Sigma n) \times 100 \quad (2)$$

Species Coverage (*Ci*) is a coverage area of the species in the area of square. The equation to calculate the species coverage is:

$$Ci = \Sigma BA / A \quad (3)$$

where: $BA = \pi\ DBH2/A$; ($\pi = 3.14$); *DBH* = trunk diameter of the species (*Rhizophora, Avicennia, Bruguiera,* and *Xylocarpus*); $DBH = CBH/\pi$; *CBH* is the circle of the chest-high trees; *A* = total area of sampling area (the area of a square of 10 m x 10 m). The value of species coverage is used to calculate the relative coverage of species (*RCi*), i.e. the ratio of species coverage (*Ci*) and a total coverage of all species (ΣC), with the equation:

$$RCi = (Ci /\Sigma C) \times 100 \quad (4)$$

Species Frequency (*Fi*) is a chance discovery of a certain species in a sample plot (a square of 10 m x 10 m) which is observed:

$$Fi = Pi / \Sigma P \quad (5)$$

where *Fi* is the species frequency, *Pi* is the number of sample plots (a square of 10 m x 10 m) where found a certain species. While *P* is the total number of sample plots. The value of *Fi* is used to estimate value of the Relative Frequencyof the species (*RFi*), which is the ratio between the species frequency (*Fi*) and the total requency (ΣF):

$$RFi = (Fi / \Sigma F) \times 100) \quad (6)$$

Importance Value Index (*IVI*) is the sum of the value of species density (*RDi*), the relative frequencies (*RFi*), and relative coverage (*RCi*).

$$IVI = RDi + RFi + RCi \quad (7)$$

These important values to give an insight into the role of a species in the mangrove ecosystems. Important value index has a range of between 0 - 300 [7].

According [8] and [9], the value of the economic benefits from natural resources, consisting of: (1) utility value , namely the value of direct benefits and value of indirect benefits and (2) the value of non-utility , covering the value of the benefits of option and value for the benefit of existence.

a. Direct use value

The value of direct benefit is value from direct utilization of natural resources. Direct benefit can be defined as the benefits that can be consumed. The total value of the direct benefits of mangrove forests is calculated by the equation:

$$DUV = \Sigma\, DUVi\ DUV2 + ... + DUV8 \qquad (8)$$

Where : *DUV* = direct use value; *DUV1* = benefits of wood charcoal; *DUV2* = benefits of firewood; *DUV3* = benefits of nypah; *DUV4* = benefits of mangrove seedlings ; *DUV5* = benefits of fish ; *DUV6* = benefits of shells; *DUV7* = benefits of crab ; *DUV8* = benefits of mussel.

b . Indirect use value

Values indirect benefit is of benefit value of mangrove ecosystems are used indirectly by the public . Indirect benefits of mangrove forests may be either physical benefits are as retaining abrasion seawater [10]. The value of indirect benefits calculated by the equation:

$$IUV = \sum_{i=1}^{n} IUV_i \qquad (9)$$

Where: *IUV*: indirect use value; *IUV1*: retaining the benefits of coastal erosion; *IUV2*: the benefits of seawater intrusion prevention; *IUV2* : benefits as a provider of nutrients.

c. Option Value

Benefits of choice for mangrove forests usually using benefit transfer, namely by calculating the value of biodiversity in the mangrove ecosystem. According [9], Indonesia has value of mangrove biodiversity US $ 1,500 per km^2. This value can be used across the mangrove forests in Indonesia when ecologically important mangrove forest ecosystems and maintained naturally. This choice benefits the value obtained by the equation:

$$OV = US\$15\ per\ ha\ x\ area\ of\ mangrove\ forest \qquad (10)$$

d. Existence Value

The value of the benefits of being with willingness approach to pay (WTP) obtained from the median value as the perceived value of a society where mangrove forest resources (FAO, 2000 *in* [11]) . The method used in this calculation is the contingent valuation method (CVM), based on a person 's willingness to pay for the existence of a resource. Formula for the average WTP is as follows:

$$NWTP = \frac{1}{n}\sum_{i=1}^{n} Y_i \qquad (11)$$

Total Economic Value is the sum of all the economic value of the benefits of mangrove forests that have been identified and quantified. The total value of the benefits of using the equation :

$$TEV = DV + IV + OV + EV \qquad (12)$$

Where: *TEV* = total economic value; *DV* = value of direct benefits ; *IV* = value of indirect benefits; *OV* = the value of the benefit options; *EV* = value of benefits existence.

Analysis about community perception was conducted descriptively, includes: (1) an understanding of the function of protected mangrove forest; participation in a protected mangrove forest conservation; economic benefits of protected mangrove forests for community, the role of protected mangrove forests on regional development, understanding, concerning the formal regulations protected mangrove forest management. Value perception divided into 3 categories, namely: understanding (value 3); quite understand (value 2); and do not understand (value 1) .

Focusing the management of protected mangrove forest in the district of Batu Ampar using descriptive analysis based on the total benefits of protected mangrove forest and community perception. Management of protected mangrove forests were formulated adapted to the prevailing regulations.

3. Result and Discussion

3.1. Potential Protected Mangrove Forest

Based on the calculation of the important value index (IVI), the mangrove species dominant tree level is *Rhizophora apiculata* (216.59%), *Bruguiera gymnorrhiza* (60.57%) , Sonneratia alba (12.46%), and *Avicennia alba* (8.05%) . At the highest level IVI stake is *Rhizophora apiculata* (INP 235.50%) and the lowest was Avicennia alba (2.16%) . The same thing for the seedling is *Rhizophora apiculata* (155.79%) and *Xylocarpus moluccensis* (1.85%).

3.2. Economic benefit value mangrove protected forest

3.2.1. Direct value

The type and pattern of direct utilization of protected mangrove forest in the district of Batu Ampar ,consisting of: the utilization of mangrove to raw material charcoal, firewood, making fish species, taking crabs, barnacles, mussels, utilization of nypah leaves and seedlings of mangrove. Total direct use value of forest ecosystems protected mangrove in the study site estimated at Rp 2,929,650,000 per year (Table 2).

3.2.2. Indirect value

3.2.2.1. The value of benefit as a drag abrasion

The physical benefits are benefits as a drag abrasion estimated from the manufacture of hydraulic structures, namely the breakwater (breakwater). Based on an analysis of unit price (AHSP) of public works, the cost of facility construction of breakwaters (break water) 1 x 11 x 2.5 m (length x width x height) Rp 4.7142 million [12] . Based on the assumption of the magnitude of the rate of inflation the value of money at the time of the study amounted to 8 % , then the cost of facility construction of breakwaters (break water) 1 x 11 x 2.5m is Rp5,091,336 with the durability of the building about 20 years. The length of the beach and mangrove forest in coastal areas of Batu Ampar District is 13,980 m, so that the manufacturing cost of the breakwater with 20 years durability are all Rp71,176,877,280. Therefore, the cost benefits of mangrove as retaining the abrasion is Rp3,558,843,864 per year.

Table 2: The value of the direct benefit of protected mangrove forest ecosystems in the District of Batu Ampar

No	Type Benefit	Value Benefit (Rp/ yr)	Operating Costs & Investment (Rp/ yr)	Net Benefit Value (Rp / yr)	Percentage (%)
1	Wood charcoal	1,656,250,000	631,250,000	1,025,000,000	34.99
2	Firewood	333,270,000	52,372,000	278,898,000	9.52
3	Nypa	36,000,000	21,000,000	15,000,000	0.05
4	Mangrove seedlings	270,000,000	157,500,000	112,500,000	3.84
5	Fish	756,000,000	126,540,000	629,460,000	21.49
6	Shells	289,377,000	8,523,000	289,377,000	9.88
7	Crab	420,750,000	54,000,000	366,750,000	12.52
8	Mussel	286,195,000	73,530,000	212,665,000	7.26
	Total value	4,047,842,000	1,124,715,000	2,929,650,000	100.00

3.2.2.2. The value of benefit as a deterrent of seawater intrusion

The benefits of mangrove ecosystems as deterrent or barrier of seawater intrusion is equivalent to the estimated value of the decline in rice production and quality of the field due to sea water intrusion wetland. Average rice production in the village of Nipah Panjang in Batu Ampar District before the intrusion of seawater was 2,000 kg per ha per year [13]. After the intrusion of the sea, rice production resulting average to 900 kg per ha per year. The value of revenues lost due to sea water intrusion estimated at 1,100 kg per ha per year, or Rp 5.06 million per ha per year, assuming the price of rice at the time of Rp 4,600 per kg. Rice area in the vicinity of protected mangrove forest ecosystems in Batu Ampar is approximately 61.29 ha. Revenue value of rice which is lost due to the intrusion of seawater is 67,419 kg per year, or Rp 310,127,400 per year. Based on these calculations, the indirect benefits value of protected mangrove forest as a barrier of seawater intrusion is Rp 310,127,400 per year.

3.2.2.3. The value of benefits as a provider of nutrients

Besides the physical benefits, other indirect benefits are the biological effect, in this case as a provider of natural food for fish. This benefit is approximated using a regression equation mangrove forest area and production of shrimp (Naamin, 1984 *in* [14]). Size of protected mangrove forest area in the district of Batu Ampar (3 villages sampling) is 5,189.52 ha. Shrimp production that can be obtained from the protected mangrove forest is 18.12 kg per year. Based on interviews with respondents, the price of shrimp feed is Rp13,000 per kg and 1 kg of shrimp requires 2 kg of feed. Based on these data, the value of the benefits of mangroves as a provider of natural food for marine life Rp 471,146 per year .

3.2.3. Option value

Benefit option value protected mangrove forest refers to the value of the benefits of biodiversity (biodiversity). According Ruitenbeek (1991), the value of the benefits of biodiversity in Bintuni Bay, Irian Jaya, Indonesia is US $ 1,500 km^2 (US $ 15/ha). Based on the calculation of the value of the benefits of option by using the exchange rate against the dollar at the time of the study, i.e. Rp 13,332 (September 2015), obtained a value of Rp 199,980 per ha per year. Benefit option value protected mangrove forest in the district of Batu Ampar protected mangrove forest with an area of 5,189.52 ha is Rp 1,037,800,210 per year.

3.2.4. Existence value

According to [15], the education level of respondents were likely to provide value where higher compared with that of less educated respondents. Based on the interview, respondents were secondary school education Up gives the average value of the existence of Rp 7,694,444.44 per ha per year . Junior High School educated respondents give an average value of Rp 6,676,470.59 per ha per year. The respondents were primary school education gives the average value of the existence of Rp 4,134,615.38/ha/year. Thus, the average value of the existence of protected mangrove forest ecosystem given by the people around the area is Rp5,277,272.77 per ha per year. Thus the total value of the benefits of protected mangrove forests in the district of Batu Ampar are: Rp27,386,581,500 per year .

3.2.5. Total economic value of mangrove ecosystems (TEV)

The results of the analysis of the total economic value of mangrove ecosystems (Table 3) in the District of Batu Ampar show that the existence benefit of protected forest areas of mangrove have a highest value (77.75%), followed by the value of indirect benefits (10.98%), the value of direct benefits (8:32%) and value benefit option (2.95%).

Table 3: The total value of economic benefits of protected mangrove forest in the District of Batu Ampar, Kubu Raya Regency

No	Type Benefit	Value of Benefits (Rp/yr)	Value of Benefits Average (Rp/ha/yr)	Percentage (%)
1	Direct value	2,929,650,000.00	564,531.99	8.32
2	Indirect value	3,869,442,410.00	745,626.26	10.98
3	Option value	1,037,800,210.00	199,980.00	2.95
4	Existence value	27,386,581,500.00	5,277,286.05	77.75
	Jumlah	35,223,474,120.00	6,787,424.30	100.00

The data in Table 4 above shows that the protected mangrove forest in the District of Batu Ampar has a big role

to community, either directly or indirectly, mainly as a source of income to meet the needs of daily life and as controlling the quality of the environment, namely as a buffer coastal erosion, prevent seawater intrusion, and as a food source for marine life.

3.3. Community understanding to the management of mangrove protected forest

One of key indicators of successful of natural resources management is the community [16] [1]. The results of analysis of community perceptions about the existence of protected mangrove forest in the District of Batu Ampar show that people have a good level of understanding about the function and benefits of the protected mangrove forest (Table 4).

3.4. Management of protected mangrove forest in the District of Batu Ampar

Values protected mangrove forest utilization is calculated based on the value of benefits and costs so as to produce the optimum utilization [17]. Priority of environmental services and utilization activities can be run in a long time thus provide environmental benefits derived from ecological sustainability [18]. Based on the results of the economic benefits as well as the community perception in the coastal of Batu Ampar District, it can be concluded that the the highest benefit value of protected mangrove forest in Batu Ampar is the value of the the existence benefits and the community perception to the functions and existence benefits of protected mangrove forest. The total economic value of utilization of protected mangrove forest is Rp35,223,474,120 per year or around Rp6,787,242 per ha per year. That total economic value is still under the economic value of the others benefits of protected mangrove forests as yet unidentified. It means that one use does not negate the use of the other. Utilization is conducted in accordance with the capacity and capability of the resources of existing mangrove ecosystems.

Table 4: Community understanding to the management of protected mangrove forest

No	Assessment criteria	Percentage (%)		
		Understand	Quite Understand	Less Understand
1	An understanding of the function of protected mangrove forest	74	18	8
2	An understanding of participation in a protected mangrove forest conservation	56	22	22
3	The economic benefits for the community protected mangrove forest	74	26	-
4	The role of protected mangrove forests on regional development	58	22	20
5	Formal regulations related knowledge management of protected mangrove forest	14	26	60

Laws and regulations related to the management of mangrove forests nationwide, namely the Presidential Decree number 73 of 2012 (Kepres 73/2012) about the National Strategy of Mangrove Ecosystem Management and Government Regulation No. 6/2007 jo Government Regulation 3/2008 (PP 6/2007 jo PP 3/2008), particularly the articles relating to the utilization of protected forest, which is the elaboration of Law No. 41/1999 on Forestry. That Government Regulations through article 23 until article 30 regulate three utilization activities in protected forest that can be done, namely utilization of area, utilization of environmental services and the collection of non-timber forest products.

Management of protected mangrove forest in the District of Batu Ampar combine economic and ecological benefits in the zoning system which is divided into 2 zones, namely: biodiversity conservation zone/protection zone and limited use zone. Some principles utilization include: (1) utilization of mangrove ecosystem must be balanced with the rehabilitation and conversion of mangrove ecosystems should be controlled; (2) utilization of protected mangrove forest ecosystem protection function does not cause loss of biodiversity, shorelines and other coastal resources; (3) community-based management of mangrove ecosystems to preserve the value of important ecological, economic and socio-cultural; (4) The powers and duties of local governments (provincial, district/city), especially the forest department in managing forest ecosystems protected mangrove should be in accordance with the conditions and aspirations of local, national strategy and management of mangrove ecosystems and (5) the management of mangrove ecosystems implemented through a partnership with support the parties and the national and international community.

4. Conclusions

The diversity of mangrove species based IVI in protected mangrove forest District of Batu Ampar at tree level includes *Rhizophora apiculata* (216.59 %), *Bruguiera gymnorrhiza* (60.57%), *Sonneratia alba* (12.46%) and *Avicennia alba* (8.05%); the saplings, *Rhizophora apiculata* (235.50%); and for seedlings, *Rhizophora apiculata* (155.79 %). The value of the economic benefits of protected forest mangrove highest is the value of benefits where Rp 27,386,581,500 per year (77.75%), followed by the value of indirect benefits Rp 3,869,442,410 per year (10.98%), the value of direct benefits Rp 2,929,650,000 per year (8.32%) and the value of choice benefits Rp 1,037,800,210 per year (2.95%). The level of community understanding is high relatively for the function of protected forests (74%) and economic benefits of protected forests (74%). The utilization zone on protected mangrove forest in the District of Batu Ampar can be divided into 2 zones, namely biodiversity conservation zone or protection zone and limited use zone.

5. Recommendations

Management of protected mangrove forest utilization in a sustainable manner in the District of Batu Ampar is divided into 2 zones, namely the protection zones and limited use zones. These efforts need to be supported by an increase in community perception, especially an understanding of community participation in protected mangrove forest conservation and related knowledge of formal rules.

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