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Economic valuation of Mangrove ecosystem for sustainable use and management in Makassar

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This study aims to identify the type and function of ecosystems of mangrove forests, calculate the total economic value of mangrove ecosystems and explain what factors affect the willingness to pay. The analytical method used is economic valuation and willingness to pay community. The results showed that mangrove species in Untia Makassar City is dominated by *Avicennia marina* and *Bruguiera gymnorrhiza* with formation thicknesses ranging from 2 to 60 meters. The total economic value of mangrove forests in Untia region of Makassar is IDR. 14.616.988.100, - contribution is greater than the value of direct use. Revenue level is the most influential variable on the willingness to pay the community. This is because the value of the equation used gives positive value to the income of the local people to the willingness to pay, while other variables include: respondent's age, Respondents 'Respondents' and respondent's education have negative effect, this indicates that the higher income of respondent will give Very high contribution value to mangrove ecosystem.

Keywords: Economic Valuation, Environmental Services, mangrove, Makassar

INTRODUCTION

As one of the coastal ecosystems, mangrove forest is a unique and prone ecosystem. This ecosystem has ecological and economic functions (Lee, S. Y. et al., 2014 ; Mukherjee N, et al., 2014) Ecological functions of mangrove forests include: shoreline protection, preventing sea water intrusion, habitat (habitat), feeding ground, nursery ground, spawning ground for various aquatic biota, Tsunami disaster mitigation, as well as micro climate regulator (Lee, S. Y. et al., 2014.; Mukherjee N, et al., 2014). While the economic functions, among others, as a producer of household needs (charcoal) and industrial purposes, and seed producers. The mangrove area of Makassar City is around 149.5 Ha and the area of *nipah* tree is 378,4 Ha. The thickness of mangrove vegetation ranges from 2-5 meters and is dominated by *Avicennia marina* and *Rhizophora*. The mangroves in Biringkanaya sub-district are

still well preserved, while in the coastal areas of Tamalate and Mariso sub-districts the mangrove ecosystem is diminished due to the high development activities in the region. This mangrove forest has a big role for the surrounding ecosystem. The fruit can be used as food, the tree can withstand coastal abrasion, habitat of various species of fish and other ecological functions (Mohammed Aatur Rahman; Sowmen Rahman, 2015). However, these ecosystems begin to experience development pressures both directly and indirectly. Therefore, its management should be an integral part of integrated coastal zone management and watershed management (watershed) as a whole.

MATERIALS AND METHODS

Research sites

The research was done on early 2017, carried out in the Coastal Coastal Area of Makasaar which is overgrown with mangroves and the communities around the mangrove forest are doing a lot of activities utilizing the function of mangrove forest resources.

Sampling Method

Methods of collecting socioeconomic data will be done by using the sampling technique Non-Probability sampling where sampling techniques are found or determined by the researchers themselves or according to expert consideration. This method aims to know the behavior, interaction, and level of welfare of the community around the study site Data analysis In accordance with the objectives of the research to be achieved, the analysis model used is as follows:

Economic Assessment Analysis

The total economic value of the mangrove forest ecosystem under study is formulated as follows: Pierce and Moran (1994)

$$TEV = DUV + IV + OV + EV + BV \quad (1)$$

Where :

- DUV : Direct Use Value
- IV : Indirect Use Value
- OV : Option Value
- EV : Existence Value
- BV : Beques Value

Each of these values was identified by virtue of all the benefits gained in the mangrove ecosystem under study. Each of these values is as follows:

A. Direct Benefit or Direct Use Value (DUV)

The formulas used to get the total value of direct benefits are:

$$TDV = VL1 + VL2 + VL3 + VL4 \quad (2)$$

Where :

- TML = Total Direct Value
- VL1 = Value of Fish
- VL2 = Value Crab (*Scylla serrata*)
- VL3 = Value of Mussels
- VL4 = Value manrove Wood

Indirect Benefits

The immediate benefits of mangrove forests as a coastal abrasion retainer can be determined from the cost of making breakwater along the coastline adjacent to the conservation area.

Option Value

The value of this preferred benefit is obtained by the equation:

$$OV = US \$ 15 \text{ per ha. } \times \text{ mangrove forest area}$$

OV = option value.

D. Benefits of Existence

These benefits can be formulated as follows (Ruitenbeek, 1992)

$$ME = \sum_{i=1}^n (MEi) / n \quad (3)$$

Description: ME = Benefit of Existence

MEi = Ecosystem benefits from the i-th respondent

N = Number of respondents

Bequest Value

Bequest value is defined as the value given by the present generation by providing or inheriting resources for future generations. The inheritance value of mangrove ecosystems cannot be assessed by market value approach, therefore, bequest values can be calculated by approximate approach. Accordingly, it is estimated that the inheritance value is not less than 10% of the direct benefit value of the mangroves (Ruitenbeek, 1992)

Contingency Values Analysis

To know the willingness to pay the community (WTP) is done by approach analysis of Contingent valuation Method (CVM) (Bateman *et al.*, 1994 ; Adamovich *et al.*, 1995) with the following formula: $WTPi = f (X1, X2, X3, X4) \quad (4)$

Where:

- X1 = Age
- X2 = Revenue Rate of Respondents
- X3 = Respondents 'Respondents' Family
- X4 = Education Level of Respondents

The analysis model is done by stepwise regression which is assumed to have influence variable, that is the respondent's age variable (X1), respondent's income level (X2), dependent of respondent's family (X3), education level of respondent (X4).

RESULTS AND DISCUSSION

Mangrove Vegetation Condition

The coastal city of Makassar is an "emergence" beach or coastal slopes formed from the mainland that was originally dominated by mangrove cover or a relatively thin mangrove community along the coast, but has been transformed into an open beach and largely utilized for the benefit of settlements, trade and Services. (Brown,1997 ; Barbier *et al.*, 1997). However, some locations, especially Biringkanaya Subdistrict, Tamalanrea Subdistrict, Pannakukang Subdistrict and Tamalate Sub District still have

mangrove vegetation.

Based on the results of research indicate that mangroves grown on the coast of Makassar City including in Untia region dominated by the type of *Nypa fruticans*, which mostly grow and develop along the watershed, then *Rhizophora apiculata* type which is the result of planting of mangrove rehabilitation program. The remaining natural mangrove and still found in this area are: *Avicennia marina*, *Bruguiera gymnorrhiza* and *Bruguiera cylindrica*. While mangrove follow-up which is generally included in coastal plants or a collection of mangroves that live behind natural mangroves (land vegetation) is dominated by *Ipomoea pescaprae*. The thickness of the mangrove formation that extends along the coastal area of Makassar City is quite varied. Results of satellite image interpretation and field measurements found that the thickness of the formation ranged from 2 to 60 meters, the thickest formation was found in along the coast of Biringkanaya Sub-district. The thickness of mangrove formation at this location is the result of mangrove rehabilitation from existing government programs.

Up to now from 8 types of mangroves in the coastal city of Makassar is the type of *Avicennia marina* and *Bruguiera gymnorrhiza*. Mangrove forest management should be very wise because it takes a long time to recover. Due to the destruction and mangrove forest that resulted in the decreasing function of mangrove forest in Makassar include:

1. Function as a protector or retainer of abrasion, so that people living around the mangrove area should increase their vigilance against the threat of abrasion that can cause damage and destruction of the house it occupies.

2. The mangrove function as employment has decreased, which has decreased the number of fishermen catch, and decreased the income of local people whose livelihood depends on the mangrove ecosystem.

3. Mangrove function which as a place most of the fish to spawning resulted in the animal threatened extinction. (Brown, 1997 ; Barbier et al., 1997)

Economic Benefits of Mangrove Ecosystems

Direct Benefits

Direct benefits or Direct Use Value (DUV) is a benefit that can be obtained from the mangrove ecosystem directly in the form of fishing, research and tourism (recreation). Direct Benefit Measurement is done by market value approach

to quantify the price of various goods obtained (Indriyanto, 2006)]. Direct Benefits of Fish Fishing is done on a shifting basis, the frequency of catching ranges from 1 time / day or an average of 4 - 28 times / month or per year ranges from 54 to 300 times or an average of 216 times. The number of catches by one catch is 3 - 5 kg, so the total catch of fish per year is 648 kg - 1080 kg or the average of 952 kg / year. With the selling price per kg ranging from IDR 20,000 - IDR 35,000 or an average of Rp.26.455 / kg. Based on these values, then obtained the total value of fish economy of IDR. 222,423,200, - / year. (Tahang, 2018)

Direct Benefits of Crabs

This crab has a very high economic value so hunted and captured by people who are in District biringkanaya, Makassar using a simple fishing tool that is bubu / rakkang. This tool is operated on a daily basis by the community. The price of mangrove crab (*Scylla serrata*) is sold between IDR 25.000 - 50.000 / kg. The size of 1 kg is equal to 3 - 5 tail with varying sizes, 1 kg = 3 large size tail + 1 medium size or 3 medium size plus 2 large size tail. This price is still quite cheap when compared with the price in the market of Makassar is between IDR 25,000 - 50.000 / kg. Whereas small-sized communities do not sell it but are consumed for daily needs. Sales of mangrove crabs are usually done in front of the house or offered to neighbors who do not catch, the community also sells it to collectors and not sold to the market (Tahang et al., 2018). This is because the cost of transport is quite expensive, difficult access to public transportation because the location is far from urban areas. Based on these values, then obtained the total value of crab economy of IDR 135,680,000, - / year.[4]

Direct Benefits of Shellfish

Based on the results of interviews with respondents, the activities of collecting mangrove shells are not routinely performed, but when averaged, the activities are generally done once a month because it depends on their wishes, and usually also from the ordering of people who trade food stalls and restaurants asking them To collect shells. Each time the collection of mangrove shells, the community is able to collect 10 kg to 30 kg at a price of 10,000 - 25.000 / kg. The cost incurred by the community for each time to collect mangrove shells about Rp. 5,000. But the disadvantage is that people do not sell the shells separately but are sold in the form of whole meat

and shell. This is because the lack of creativity and community experience in using shell shells to be made crafts / souvenirs such as earrings, necklaces, bracelets, tissue places and so forth. Factors affecting the lack of creativity and community experience are due to low level of education, lack of capital, as well as the lack of specialized training provided by the government and related institutions. Based on these values, the total value of shellfish economy is IDR 47,150,000, - / year. (Kusmana, 1997: Tahang et al., 2018)

Direct Benefits of Wood

According to one community in the region that the wood that can be used as firewood is mangrove wood because it can produce high heat and durable. Types of mangroves that are often used as firewood are from Rhizophora sp and Bruguiera sp. (Tolangara, 2014) Firewood obtained by the community is generally used for domestic consumption and for sale. The people in general routinely take timber, but with the enactment of regulations from the government on the establishment of mangrove forest protection area in Makassar City, causing people are reluctant to search for firewood. Not enforced sanctions if mangrove trees are taken in a state of death. Usually they only look for once a week or even once a month with the number of taking reaching 1-3 bunches. The price set by the local community for each bundle at a price of Rp. 10.000 / bunches. Because the location of mangrove forest adjacent to their village, but the location for the sale far from where they live in the traditional markets in the urban expenses are also quite a lot. Based on these values, the total value of shellfish economy is (in Indonesian currency IDR 13.500 equivalent 1 U\$) IDR 4,260,000, - / year.

Total Economic Value Direct Benefits

The total economic value of direct benefits of mangrove ecosystem in Kelurahan Untia, Biringkanaya Sub-district, Makassar City is the sum of the four types of direct benefits available (in Indonesian currency IDR 13.500 equivalent 1 U\$) Table 1.

Indirect Benefits

Indirect benefits are the perceived benefits indirectly to the goods and services produced by the resource and its environment. Based on the results of identification of the existence of mangrove forest in Untia, Biringkanaya sub-

district, Makassar city, the value of indirect benefits is done by approaching the value of the retaining waves. The function and role of mangrove ecosystem as a wave holder is very important to keep the city area from the waves. Direct mangrove naturally cannot be measured with market value (marketable) so that to measure the value of physical measurement is done with the approach to the cost of making waves retainer.

Table 1; Total value of direct benefit of mangrove ecosystem.

No.	Direct Benefit	(Rp/year)	(Rp/ha/year)	(%)
1	Fish	222,423,200	22,242,320	54.31
2	Crab	135,680,000	13,568,000	33.13
3	Clams	47,150,000	4,715,000	11.51
4	Fire wood	4,260,000	426,000	1.04
Total		409,513,200	40,951,320	100 %

The construction of wave retaining requires materials such as cement, mountain rock, sand, and concrete iron. Costs allocated to build waves in the coast of Makassar, Biringkanaya sub-district, kelurahan Untia estimated at IDR 962.500, -. The average height of Break Water in Kelurahan Untia, Kecamatan Biringkanaya, Makassar is 2.5 meters. Detailed estimates of the calculation of the construction of the breakwater (Break Water) in West Coast of Makassar City as follows:

- Long coastline overgrown with mangrove forest: 10,000 m²
- Break Water Width: 50 cm
- Average Height: 2.5 m
- Durability: 10 Years
- Break Water Price: Rp. 1.412.500

Indirect Benefit Value = 10,000 m² x IDR. 1.412.500

= IDR

14,125,000,000, - or

= IDR.

1,412,500,000 / year

Thus the cost and benefits of the mangrove forest ecosystem as retaining waves in the Village Untia, Biringkanaya Sub-district, Makassar is IDR 9.625.000.000, - or IDR 962.500.000, - / year, with the width of break water 50 cm, average height Break water 2.5 m.

Based on the result of quantification of indirect benefits (carbon sink and wave arrest) mangrove forest ecosystem in Kelurahan of Untia, sub-district of biringkanaya, Makassar City, total total indirect benefit value is IDR. 962.500.000, - / Year

Option Value

The value of the choice of mangrove ecosystem in Kelurahan Untia is approached with the benefits of biodiversity (biodiversity). The value of the rupiah per dollar is IDR. 12,690. Taking into account the biodiversity value of mangrove, using benefit transfer. Assumed the value of choice = value of mangrove forest biodiversity in Kelurahan Untia, subdistrict biringkanaya, Makassar City is US \$ x 15 per ha per year (ruitensbeek, 1992). Value of choice = value of biodiversity x the value of the rupiah against the dollar during the study. (\$ 15 per ha per year x IDR12,690 per US \$ = IDR 190,350 per ha per year) it is known that the mangrove forest area is 10 ha, the benefit value of choice per ha per year is IDR 190,350 Per ha per year x 10 ha = IDR 1.903.500 / year.

Existence Value

With the same approach and method with inheritance value, but the willingness to pay in question is the willingness to pay the community for the maintenance of the mangrove ecosystem although the community will not use or visit it, then the value of existence can be determined (Carandang et al., 2013 ; Mukherjee N, et al., 2014) using valuation techniques in the survey so that WTP obtained by using CVM technique. The value of the existence of mangrove ecosystem.

Table 2; Existing value mangrove ecosystem and respondent, Makassar

No	WTP	Respondent	WTP
1	1,000,000	13	13,000,000
2	5,000,000	27	135,000,000
3	10,000,000	10	100,000,000
Total		50	248,000,000
Average			4,960,000

The table above shows that the willingness to pay the community (WTP) as many as 13 people for Rp.1,000,000, and as many as 20 people for IDR.5,000,000, while the WTP of IDR 10,000,000 as many as 10 people. Then obtained the value of the existence of the existence of IDR. 4.960.000 per ha per year, if multiplied by the area of mangrove forest (10 ha) = IDR 49.600.000, - / year.

Bequest Value

The mangrove ecosystem as an inheritance has a very high value. Bequest value of mangrove

ecosystems cannot be assessed by market value approach. Therefore, inheritance values can be calculated by approximate approach. Accordingly, it is estimated that the inheritance value is not less than 10% of the direct benefit value of the mangroves(Rizal *et al.*, 2018)

Thus, in relation to the total value of direct benefits from the mangrove ecosystem, the mangrove heritage value in Kelurahan untia, Biringkanaya sub-district, Makassar City is 10% x 409,513,200 = IDR 40,951,320 / year.

Total Economic Value (TEV) Mangrove Ecosystem

Results of the assessment that has been done, mangrove ecosystem Biringkanaya Sub-district, Makassar City has several benefits, namely direct benefits, indirect benefits, benefits of choice, benefits of existence, and inheritance benefits. Direct benefits include direct benefits of fish, direct benefits of mangrove crab (*Scylla serrata*), direct benefits of shellfish (*Anadara spp.*), Direct benefits of firewood. Indirect benefits of mangrove ecosystem function as coastal protection from abrasion with cost approach. Benefits of choice obtained from the identification of the biodiversity value of the mangrove ecosystem. As for other benefits is the existence of ecosystems obtained from the value of paying the respondent / community (WTP), and inheritance benefits are estimated not less than 10% of the benefits directly mangrove.

The total economic value (TEV) is based on the results of the identification of all types of benefits from the mangrove ecosystem in Untia, Biringkanaya sub-district, Makassar City, then calculated all the benefits. The recapitulation of the total estimated value of the benefits of mangrove ecosystem is presented in the following table:3

The results show the Total Economic Value of mangrove ecosystem , Biringkanaya Sub-district, Makassar with area of ± 10 ha is IDR 14,616,988,100, - / year or IDR 1,461,698,810, - / ha / year. The indirect benefits of mangrove ecosystems around the Kelurahan of Untia Beach, Biringkanaya Sub-district, Makassar contributed the most with IDR 14,125,000,000. With the results obtained indicate that the community is very dependent on the potential of the mangrove ecosystem and already understand and understand about the role function of the ecosystem as a protector of the beach and their residence from the brunt of the waves.

Table 3. Total Economic Value Mangrove ecosystem, Bringkanaya Makassar

No	Benefit	Value (Rp/Year)	Value(Rp/ha/Year)	Value (%)
A	Direct value			
1	Direct value of fish	222,423,200	22,242,320	
2	Direct value of fish Crab	135,680,000	13,568,000	
3	Direct value of shellfish	47,150,000	4,715,000	
4	Direct value of wood	4,260,000	426,000	
	Direct Value Total	409,513,200	40,951,320	2.80
B	Indirect value	14,125,000,000	1,412,500,000	96.63
C	Option Value	1,903,500	190,350	0.01
D	Existence Value	49,600,000	4,960,000	0.34
E	Bequest Value	30,971,400	3,097,140	0.21
	Total Economic Value	14,616,988,100	1,461,698,810	100 %

The value of each benefit of the mangrove ecosystem has a very important role for the environment. The economic value of mangrove direct benefits indicates that people Biringkanaya. Makassar City They have realized that damage to the ecosystem will result in a decrease in their income which will also indirectly affect the level of welfare. For the benefit of inheritance, the benefits of existence, and the benefits of choice that, when combined into one, then have enormous value. The magnitude of benefit value obtained in this study may change in the future because it depends on the change of utilization type.

Contingency valuation analysis

Stepwise regression is one method to get the best method from a regression analysis where with this analysis can be known variable which have significant effect and if there is variable which is not significant then the variable is issued (Tuan et al., 2014 ; Amirnejad and Jahanifar , 2018) The analysis model is done by stepwise regression which is assumed to have influence variable, that is age variable of respondent (X1), income level of respondent (X2), Respondent Family count (X3), and education level of respondent (X4). To see the factors that affect the value of this PAP, SPSS software is used. From the statistical analysis, the existence value of mangrove ecosystem Biringkanaya sub-district, Makassar given by respondent based on paying (WTP), minimum is Rp 1,000,000 per hectare and maximum is Rp 10,000 Per hectare, while the mean value of willingness to pay for each hectare of coral reef ecosystem is Rp 4,960,000.

Based on the results of step wise regression education level (X1) and age (X4) of respondents that, there is a tendency that the higher level of education and age level, the greater the value of

existence of ecosystems in the coastal city of Makassar. Respondents who have junior high education are 14 people with age range of age of 29 - age 50. A total of 3 people give the value of existence of mangrove ecosystem IDR 1.000.000, - per hectare, 7 people give value IDR 5.000.000, - per hectare, 4 people Respondents gave a value of 10,000,000, - per hectare. For respondents who have elementary education as many as 27 people with age ranges of age 27 - age 68. A total of 8 people provide the value of the existence of mangrove ecosystems of IDR 1.000.000, - per hectare, 13 people provide value Rp 5.000.000, - per hectare, 6 The respondent gave a value of 10,000,000, - per hectare. While the respondents who do not continue their education as many as 9 people with age range that is age 32 - age 52, giving average value IDR 5.000.000, - per hectare, only 2 people give value IDR 1,000,000, - per hectare.

The result of stepwise regression analysis in the above table shows that the existence value of mangrove ecosystem in Biringkanaya Sub-district, Makassar City based on the willingness to pay the community obtained by regression equation as follows:

$$WTP (Y) = 0,332 - 0,021 (X1) + 0,167 (X2) - 0,019 (X3) - 0,019 (X4)$$

By using the above equation it can be concluded that the income level (X2) is the variable that has the most positive effect on the willingness to pay the community in Biringkanaya Sub-district, Makassar City. This is because the value of the equation above gives a positive value on the income of the local community to the willingness to pay, while other variables include: age of respondent (X1), Respondent Family count (X3), and respondent education level (X4) , This indicates the higher income of respondents will give a very high contribution value to mangrove

ecosystem. This means that respondents generally realize that the destruction of the mangrove ecosystem will greatly affect the level of income that adversely affects their welfare so that the community or respondents will switch to other livelihoods due to the loss of the main livelihood. Based on the above regression model, it can be interpreted that one's income can positively influence the PAP of coastal community of Makassar.

CONCLUSION

Type of mangroves in the region of Untia is the type of *Avicennia marina* and *Bruguiera gymnorrhiza* with a thickness of the formation ranges from 2 to 60 meters, keeping the shoreline remains stable. Because if the decrease of mangrove forest area decrease its function so that it threatens the survival of the people living in the forest area either from the threat of abrasion, decreasing of income due to decreasing of catch and other livelihoods obtained from mangrove forest.

The total economic value produced by mangrove forests in biringkanaya, Makassar City is IDR. 14.616.988.100, - the contribution is greater than the direct use value (direct use value).

Revenue level is the variable that has the most positive effect on the willingness to pay the people of Makassar. This is because the value of the equation used gives positive value to the income of the local people to the willingness to pay, while other variables include: respondent's age, Respondents' Respondents, and respondent's education level negatively, this indicates the higher the respondent's income will Provide a very high contribution value to the mangrove ecosystem.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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