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Valuation of Mangrove in Kupang Bay, West Timor, Indonesia (A Case Study of Bipolo Village)

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ABSTRACT:

BACKGROUND AND OBJECTIVES: Mangrove in Bipolo Village, located on Kupang Bay, East Nusa Tenggara (NTT), is part of the ecosystem of the Marine Tourism Park of Kupang Bay established by Decree of the Minister of Forestry of Indonesia No. 18/Kpts-II/1993. A critical question that needs to be addressed regarding the value of mangrove resources. This study has analyzed various aspects of mangrove conversion to salt pond, especially the economic value of mangrove based on market prices for the various outputs. This study used accidental sampling to collect information regarding the benefits (products and services) produced by mangrove for people who have socio-economic (livelihood) activities along the bay coastline. Purposive sampling was used to collect information from the investors and laborers in the salt pond industry regarding the technical details of the salt industry salt production.

METHODS: This study analyses (i) the types and components of input and output for salt production, (ii) the value of mangrove utilization based upon production volume and Market Price/ha/year, (iii) the value of mangrove wood, (iv) the recapitulation of type and direct benefit of mangrove resources, (v) the value of physical function of indirect use of mangrove, and (vi) the total economic.

FINDINGS: The results of the research show that (i) the values indicate that natural resources and the envi-ronment need a higher level of appreciation, and (ii) the total economic value of mangrove vegetation in Bipolo Village, which reaches IDR374,731,172/ha/year or US $ 25,622/ha/year, could be considered as the compensation fee paid by commercial industries that convert mangrove vegetation for commercial purposes.

CONCLUSION: This compensation fee could benefit the local authority for mangrove restoration projects.

KEYWORDS:Valuation, Economy, Mangrove, Salt, Indonesia.

INTRODUCTION

Mangrove in Bipolo Village on Kupang Bay is part of the ecosystem of the Marine Tourism Park of Kupang Bay established by Decree of the Minister of Forestry of Indonesia No. 18/Kpts-II/1993. The marine park's ecosystem includes various species of coral reef and 203 species of fish (Ceccarelli et al., 2020; Gilby et al., 2017; Graham et al., 2020). The mangrove in Bipolo act as spawning grounds that guarantee the marine food chain by providing habitat support for a variety of species in Kupang Bay, including fish, crustaceans, mollusks, shrimp, crab, among others.However, since 2018, the new NTT Provincial Government has a policy to enhance salt production in NTT, in accordance with an import substitution policy for the national salt industry, which includes potential salt pond areas within the Kupang District, especially Bipolo Village adjacent to Kupang Bay. It has been noted that Indonesia imports roughly 3.7 million ton per year of salt, and the domestic production capacity is only 1.1 million ton per year. Even though enacting the salt import substitution policy by enhancing salt production through conversion of mangrove area into salt ponds along Kupang Bay is economically and strategically beneficial for the development of NTT, it should be implemented in the spirit of environmental protection to make sure that the policy follows sustainable development guidelines.The new policy of the NTT Provincial Government should be approached with caution as the main orientation of the private sector is profit taking with little consideration for environment protection and the public's interest. (Allam, 2020; Jickling & Wals, 2008) emphasized that: "While the public sector becomes more privatized, the private sector is being reframed as essential for public well-being". According to (Stern, 2000),

> "through human history, environmental impact has largely been a by-product of human desires for physical comfort, mobility, relief from labor, enjoyment, power, status, personal security, maintenance of tradition and family, and so forth, and of the organizations and technologies mankind has created to meet these desires".

The fundamental problem in this research is that under the new policy of the East Nusa Tenggara Provincial Government to enhance NTT's salt production, as an import substitution policy for the national salt industry, there will be large areas of mangrove in Bipolo Village converted into salt ponds. A critical question that needs to be addressed regarding the value of mangrove resources that has to be considered as the compensation to the company that has con-verted the existing mangrove into a salt pond industry. At the same time, the goals of the research are (i) to understand the direct value of mangrove ecosystem products, including fish, crustaceans, mollusks, and other marine biota.; (ii) to understand the indirect values produced by the mangrove ecosystem regarding its functions including coastal protection, spawning grounds and fish habitat, among others.; (ii) to analyze the economic and livelihood impact of the conversion of mangrove for the salt pond industry.

Mangrove Resources

Robert Goodland overviewed the concept of environmental sustainability by a number of authors, ranging from Mill and Malthus to Brundtland, and defined environmental sustainability as simply "the maintenance of natural capital" (Barker & Mayer, 2017; Bateman & Mace, 2020; Costanza, 2020; Fang et al., 2018; Haffar& Searcy, 2018; Helm, 2019; Morelli, 2011). In relation to the issue of utilization of environmental resources for the purposes of the private sector, then according to (Benu et al., 2020):

> "local participation is actually the key issue that has to be addressed in the development process so that the process can produce sustainable benefits for all parties. Accordingly, the

local people should understand that their participation in the development process might produce a benefit for themselves in the long term".

Research conducted by (Alfahmi et al., 2019; Amron&Hilmi, 2018; Daryono et al., 2021; Priyatna et al., 2014; Purba et al., 2021; Sui et al., 2020) found that there are at least 19 different characteristics of coastlines in Indonesia, being (1) Coastline of Small Island (2) Settlement facing directly to Coastline, (3) Coast-Settlement-Hill, (4) Coast-Open land-Settlement, (5) Coast-Agriculture area-Settlement-Hill, (6) Settlement Behind Forest, (7) Settlement behind Hill, (8) Coastal-Open Land-Agriculture Area-Forest, (9) Fishpond and settlement facing directly to coastline, (10) Settlement behind mangrove, (11) Mangrove forest, (12) Gulf coast and settlement, (13) Coastal Hill, (14) Fishpond-Settlement-Hill facing directly to coastline, (15) Gulf-settlement hill facing directly to coastline, (16) Coastal forestry, (17) Open land facing coastline, (18) Fishpond-hill facing coastline, and (19) Swamp-Open land facing coastline.

Mangrove Resources

According to (Sousa et al., 2019; Turner et al., 1994), in order to arrive at an aggregate measure of value (total economic value) of natural resources, we should distinguish the concept of "use values" and "non-use values". The relationship between use values and non-use values for a woodland case is presented in Figure 1.

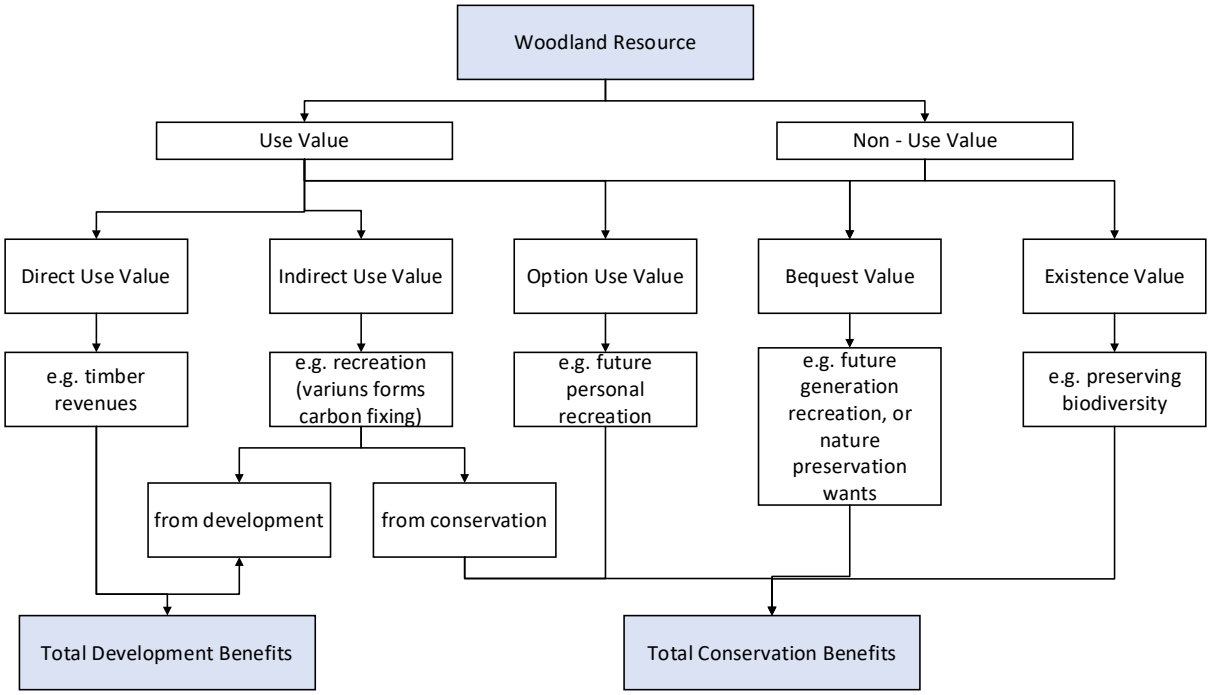

Figure 1. The total Economic Value of Natural Resources (Woodland)
Source: (Turner et al., 1994)

As shown in Figure 1 the total value of woodland can be categorized into "use value" and "non-use value". The use value itself consists of (i) "direct value" and "in-direct value", (ii) option use value and (iii) part of "bequest value". At the same time, non-use value consists of (i) "existence value" and (ii) part of "bequest value". Furthermore, any component of direct value, indirect value, option use value, bequest value and existing value will depend on the type of natural resource evaluated. The concept of total economic benefit and cost of mangrove ecosystem is seen in Figure 2.

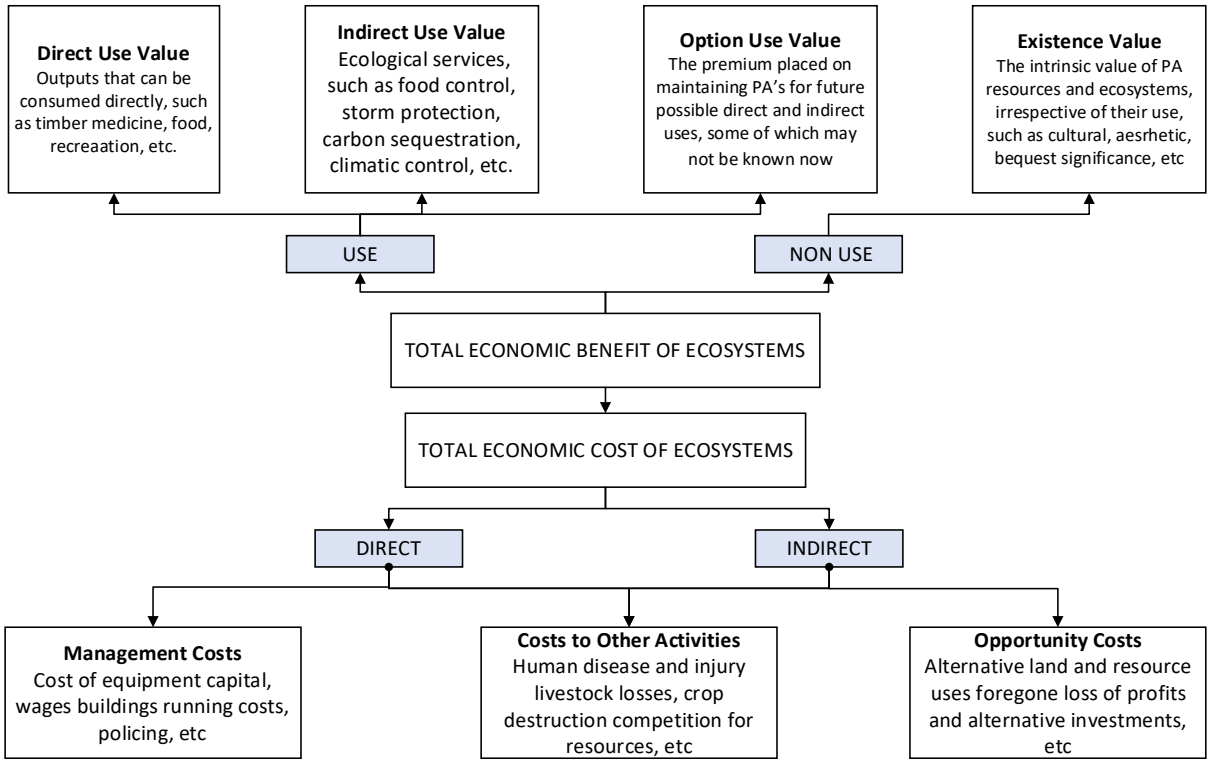

Figure 2. The Concept of Total Economic Value of Mangrove Ecosystem
Sources: IUCN, The World Conservation Union

As stated in (Plottu&Plottu, 2007) Total Economic Value (TEV):

> … highlights the multidimensional nature of the economic value of ecosystems, which ranges far beyond direct use values and encompasses indirect use values, optional values and non-use values. TEV is useful to relate to the socio-economic values (for example livelihoods) through direct use values such as fish, mollusks, crustaceans, medicines, and forest products.

In the same vein, mangrove also contributes indirect value to support economic activity through habitat provision, nutrient recycling, water purification, and flood control (de Souza Queiroz et al., 2017; Gillanders et al., 2019; Matos et al., 2020; Morris et al., 2018; Onyena & Sam, 2020). One of the most important indirect values of mangrove is the protective function provided by mangrove ecosystems against wave and storm energy, both in terms of ongoing coastal erosion and damage from extreme events (Amma & Bhaskaran, 2020; Charrua et al., 2020; de Jong et al., 2021; Gracia et al., 2018; Mafi-Gholami et al., 2020; Mentaschi et al., 2018).Based on the logical framework of this study, there is an inextricable link between the structure and processes of the ecologic functions of mangrove and the ecological-economic benefits produced by mangrove. Some benefits of mangrove ecosystem functions that can be identified, including clean water and regulation of water supply, storm protection, assimilative capacity including carbon sequestration, biochemical cycling, purification and detoxification processes, nutrient flows, biodiversity maintenance, wood for fuel and building materials, various non-timber forest products (NTFPs) and opportunities for tourism and recreational activities (Mitra, 2020; Owuor et al., 2019; Pastorinho&Pais, 2019; Rizal et al., 2018; Sofian et al., 2019).There are three methods of analysis that might be used to value all the products and services provided by mangrove including: (i) market price method to value non-fish mangrove products (NFMFP); (ii) effect on product method to value fisheries production through habitat provision; and (iii) restoration cost method to value coastal protection "Economic Value of Mangrove (Word)" (n.d.).

MATERIALS AND METHODS

This study was conducted along the coastline of Bipolo Village in the District of Kupang, East Nusa Tenggara Province (NTT) of Indonesia. The study relies on both primary data collection and the use of secondary data sources to draw conclusions. Data collection methods were focused on mangrove habitat and local community impacts. This study used accidental sampling to collect information regarding the benefits (products and services) produced by mangrove for people who have socio-economic (livelihood) activities along the bay coastline. Purposive sampling was used to collect information from the investors and laborers in the salt pond industry regarding the technical details of the salt industry salt production. This study analyzed aspects of mangrove conversion to salt pond, especially regarding the economic value of mangrove, based on market prices for the various outputs.This study analyses (i) the types and components of input and output for salt production, (ii) the value of mangrove utilization based upon production volume and Market Price/ha/year, (iii) the value of mangrove wood, (iv) the recapitulation of type and direct benefit of mangrove resources, (v) the value of physical function of indirect use of mangrove, and (vi) the total economic.The method used to assess the value of direct use of mangrove area is based upon the combined annual market value of catch-fish products, including prawns, crabs, and the value of mangrove fruit and seeds. The net direct value is calculated by taking the value of annual production, at market price, and subtracting operational costs. Meanwhile, the value of mangrove wood is calculated by the use of the following for-mula:

Vha x H = 1/2n D2TK x H-B (US $ m3/ha/year).

Where: Vha is the mangrove wood volume per ha per year for 1000 logs.

At the same time, the indirect value of mangrove is calculated based on the function of mangrove as feeding ground, nursery ground, spawning ground, and the physical value of mangrove as an abrasion barrier. Furthermore, a biodiversity value suggested by (Ruitenbeek, 1994) is used to estimate optional value of mangrove.Finally, bequest value can be interpreted as the value of nurturing resources for utilization in the future. The value of nurturing the resources might be calculated based on a prediction approach of about 10 % of the direct utilization value (Ruitenbeek, 1994).

RESULTS AND DISCUSSION

Historical Perspective

Bipolo is one of the villages located in the eastern part of Kupang Bay under the authority of the government of Kupang District, East Nusa Tenggara Province of Indonesia. Bipolo is located adjacent to the border of the capital city of Kupang District, ap-proximately 12 km from the city center. Bipolo Village is surrounded by Kupang Bay to the south, Oelatimo Village and Nunkurus Village to the east, Oeteta Village to the west, and West Fatuleu District, Oelbiteno Village and Nunsaen Village to the north (See Figure 4).The government system of Bipolo Village was actually an old government system called “Temukung Bipolo”. This traditional governmental system, together with an-other old village government system called “Temukung NaiLete”, are representative of a higher traditional governmental hierarchy which is call “Kefetoran Babau”. Furthermore, this old government system was reformed into a governmental system called “Desa Gaya Baru” based on the East Nusa Tenggara Province Governor Decree of No. 2/1/27 in 1964. This had the effect that both the previous

governmental system of “temukung” Bipolo and NaiLete, were merged into one new village government called “Desa Bipolo”.However, the traditional leadership of Bipolo Village still exists in the new gov-ernment system until now. Generally, there are four dominant clans that are the land-lords of Bipolo Village. They are Clan Tapikap, Clan Kasenube, Clan Utan, and Clan Tanono. The leadership of Bipolo Village is always rotated periodically among the four clans. Currently, the Head of Bipolo Village is TheofilusTapikap (2018-2024), who replaced Matheos Tapikap, the previous Head of Bipolo Village (2007 – 2018).

Natural Resources, Dry Land Agriculture and Food Security

Climatic conditions in Bipolo Village are generally influenced by two seasons, the wet season from December to March and the dry season from June until September. Like most regions in East Nusa Tenggara Province, the dry season during the period of June – September is determined by the wind blowing from the south with limited water vapor. The wet season is determined by the wind blowing from the north laden with an abundance of water vapor, after crossing Asia and the Pacific Ocean. This vapor laden wind first passes over other regions to the north, including Sumatra, Java, Borneo, and Sulawesi, delivering large amounts of precipitation before dropping the remaining smaller portion of water on Timor Island, including Bipolo Village. These climatic conditions determine the type of agricultural activities conducted in Bipolo Village, which are dominated by dry land agriculture. The average annual air temperature is about 30 – 36 ^{0}C with a minimum temperature range of about 21 – 24.5 ^{0}C and an average annual precipitation of about 1164 mm/year. Although there are 12 ha of dry paddy field with semiirrigated facilities, other dry land farmers on Timor Island, in relation to the hard climate condition and food security issue, develop their own mitigation and adaptation strategies to overcome extreme climate conditions such as drought and flood. Some dry land farmers, over generations have developed a traditional mixed cropping system by putting all food crop seeds in the one furrow. This coping method is to anticipate the failure of crops in extreme weather condition. In general, local Timorese farmers put food security as the first priority over income. Timorese farmers totally rely on nature as their provider, rather than on other actors such as financial institutions (banks, cooperatives), government subsidies, and NGO and research agency support.Additionally, there is population pressure on land occupation that has influenced the low productivity per capita of the available productive land. The population of Bipolo Village has tended to increase over the last 5 years. At the same time, the available area of arable land has decreased due to the conversion of productive land to settlement areas, infrastructure facilities and other economic activities. This condition has dictated an increase in agrarian density, as seen in Figure 3.

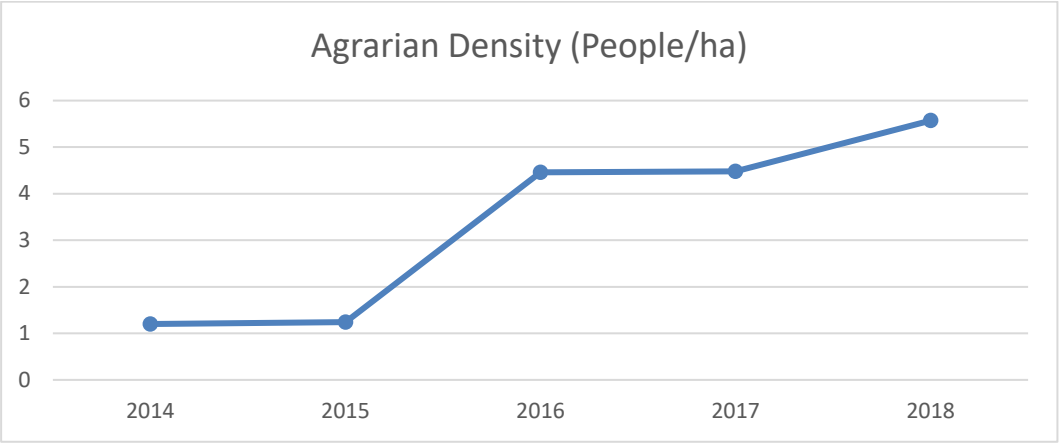

Figure 3. The Agrarian Density of Bipolo Village

Source: Central Bureau of Statistics of Kupang District

Hence, many local farmers now look to alternative livelihoods instead of totally relying on land production. (Malmberg&Tegenu, 2007) state that:

> … Livelihood strategies took different forms when both dependency and density ratios were low and when they were on the increase. When both ratios were low livelihood strategies took the form of agricultural extensification and this was due to the relative availability of land. When both ratios were on the increase, livelihood strategies took the forms of agricultural intensification and diversification...”

One of the alternative livelihoods that is available and possible is salt production. This kind of alternative livelihood is highly feasible as Bipolo Village is located along the Kupang Bay coastline. However, there are many experts that have made strong advocacy that existing and alternative livelihoods, should be managed sustainably to protect the environment and hence to support livelihoods (Ashley & Carney, 1999; Carney, 2003; Chambers & Conway, 1992; Scoones, 1998). This rationale is behind the analysis of the assimilative capacity of the existing mangrove proposed to be converted into salt production ponds, as a new alternative livelihood for the local people.Research conducted by (Benu et al., 2020) in Papela, a small fishing village on Rote Island, also in NTT Province, found that the community business of salt production can be an acceptable alternative livelihood to help overcome the scarcity of work faced by village laborers and seasonal workers in the local community.

Estimating the Economic Value of Mangrove Resources

1. Direct Benefit Value

Numerous sources indicated that the economic value of mangrove is the sum of the various inputs including capture fisheries, aquaculture, mangrove seeds, mangrove fruit, and the value of wood as a raw material for construction and arts and crafts. However, mangrove resources in Bipolo Village tend to decrease from year to year, because of human activities, especially since the provincial government of NTT released a new policy for the salt industry as one of the priority programs in 2018.The satellite image (Figure 5) shows that mangrove vegetation in Bipolo Village has been reduced from 93.94 ha in June 2017 to 76.67 ha in August 2019, or approximately 17.27 ha of mangrove (18.38 %) has disappeared because of human activities, especially the activity of converting mangrove area into salt ponds. The existing salt pond industry, owned by two large

companies, now occupies approximately 21 ha of mangrove area for production activities, not including the small amount of traditional salt pond production owned by the local community. The additional 3.73 ha out of 17.27 ha highlighted by the satellite image is actually an existing open space along the coastline of Bipolo that has been converted to salt pond. Results of vegetation analysis along the Bipolo Village coastline show that mangrove in Bipolo is now dominated by Ceriopstagal (32.45 %), followed by Avecenniaalba (22.52 %), Aegialitisannulata (22.52 %), Sonneratia alba (11.92 %) and Rhizophora apiculate (10.60 %). Generally, there are 1,510 individual / ha which is dominated by Ceriopstagal (490 individu/ha) and followed by Avicenniaalba (340 individu/ha) and Aegialitisannulata (340 individu/ha). The price of mangrove wood per m3 is IDR 5,000,000 (US $341.88). Mangrove average height is 2 m, and average wood density is 0.05πd/m2. The average diameter is 0.05m, π = 3.14. The operating costs are approximately IDR 479,416 per year. Accordingly, the value of mangrove wood is IDR 62,685,000 (US $ 4,268.15) per year. Table 1, presents a recapitulation of the types and values of the direct benefits of mangrove resources along the coastline of Bipolo village. Based on the analysis of costs and benefits of each product type, the direct economic value of mangrove resources was calculated at IDR 159,412,371 (US $ 10,900) per ha per year. This figure was then multiplied by the total area of mangrove in Bipolo Village, currently 76.67 ha. Hence, a total value of IDR12.2 Bil (US $ 835,702) per year is obtained.

Table 1. Recapitulation of type and direct benefit of mangrove resource in on the coast of Bipolo village

Type	Benefit value (IDR/Year)	Investment (IDR/Year)	Operating	Total Costs (IDR/Year)	Total Costs (IDR/Year)	Net use (IDR/Year)	Net Use (US $/ Year)	Net Use (IDR /Ha/Year)
Shrimp	4,471,200,000	2,946,667	82,944,000	85,890,667	4,385,309,333	299,850	57,197,200	3,910
Crab	1,393,920,000	1,473,333	41,472,000	42,945,333	1,350,974,667	92,374	17,620,643	1,205
Mangrove seedling	24,030,000	-	-	-	24,030,000	1,643	313,421	112
Mangrove fruit	3,585,000	-	-	-	3,585,000	245	46,759	3.197
Fish	2,425,590,000	53,881,429	719,520,000	773,401,429	1,652,188,571	112,970	21,549,349	1,473
Wood value	4,806,058,950	-	479,416	479,416	4,805,579,534	328,587	62,685,000	4,286
Shrimp	4,471,200,000	2,946,667	82,944,000	85,890,667	4,385,309,333	299,850	57,197,200	3,910
Sub-total					12,221,667,105	835,669	159,412,371	10,900

Source: Primary data analysis, 2020

2. Indirect Benefit Value

A village informant reported that the benefits of fish and shrimp in the areas around mangrove forests in Bipolo Village are not as large a benefit as from catch-fish activities outside of Bipolo waters. Table 2 shows that the value of the feeding grounds associated with mangrove areas along the coastline of Bipolo Village is about IDR 8,496,688 (US $ 581) per ha per year. At the same time, the mangrove ecosystem also provides IDR 48,737,187 (US $ 3,332) per ha per year for nursery grounds, and IDR 77,855,224 (US $ 5,323) per ha per year for spawning grounds. The biological benefit value of the mangrove region, in this instance, is calculated based on the capability of taking benefits from feeding, nursery, and spawning grounds which totals IDR 135,089,097 (US $ 9,237) per

ha per year or IDR 10,357,281,084 (US $ 708,190) per year.Furthermore, the physical value of mangrove forests as an abrasion barrier is calculated to be as high as IDR 20,803,443 (US $1,422) per ha per year or IDR 1,595,000,000 (US $109,060) per year. Other forms of indirect value provided by the mangrove ecosystem along the coastline of Bipolo Village are milkfish ponds and salt pond industries. Based on the analysis of these two industries, the mangrove ecosystem provides IDR 2,016,150 (US $ 137) per ha per year and IDR 37,495,270 (US $ 2,563) per ha per year, respectively. Both kinds of industries combined will generate a total benefit of IDR 1,053,831,033 (US $ 72,056) per year.

Table 2. Recapitulation of type and direct benefit of mangrove resource in on the coast of Bipolo village

Type	Benefit Value per ha per year		Benefit Value per year	
	IDR/ha/year	US $/ha/year	IDR/year	US $/year
Feeding ground	8,496,688	581	651,441,084	44,542.980
Nursery ground	48,737,187	3,332	3,736,680,000	255,499.487
Spawning ground	77,855,224	5,323	5,969,160,000	408,147.692
Total	135,089,097	9,237	10,357,281,084	708,190.159

Source: Primary data analysis, 2020

Based on the above calculation, it might be concluded that total indirect value of mangrove in Bipolo Village is about IDR 195,403,961/ha/year (US $ 13,361 /ha/year).

3. Optional, Existence, and Bequest Values

By following (Ruitenbeek, 1994), the biodiversity of mangrove (optional value) is valued at US $15/ha/year, which is assumed to be a good result for environmental-economic studies on various resources uses. Applying (Ruitenbeek, 1994) approach in the present situation, the use of the optional value of mangrove resources is calculated to be IDR 217,245 (US $18.50) per ha per year, and from 76.67 ha will return IDR 16,675,725 (US $ 1,140/year) per year.Based on an evaluation approach by community leaders, who are actively campaigning for planting and protecting mangrove areas, the benefit value of existing mangrove areas in Bipolo Village is IDR 3,756,358 (US $ 257) per ha per year. In other words, the existence benefit value in total generated from 76.67 ha is IDR 288,000,000 (US $ 19,692) per year.The results of the analysis show that bequest value of mangrove in Bipolo is about IDR 15,941,237 (US $ 1,090) per ha per year. In other words, the bequest value in total generated from 76.67 ha is IDR 1222,166,711 (US $ 83,567) per year.

4. Estimating the total economic value of mangrove resources

The total economic value of mangrove is calculated by identifying all types of benefits generated by mangrove resources in Bipolo Village, then summing the total value of the benefits. The results from estimating all the benefits of mangrove resources are presented in Table 3. The table shows that the compensation cost for the conversion of 76.67 ha mangrove is calculated to reach IDR 459,499,661 (US $31,419) per ha per year, or IDR 33,253,821,659 (US $2,273,766) per year. The results, of the valuation of total economic value of mangrove ecosystem in Bipolo Village, are in line with the results of the valuation of economic value estimation of mangrove ecosystems in Indonesia conducted by (Rizal et al., 2018), who found that the economic value of mangrove re-sources is estimated to range from US $3,625 to US $26,735 per ha per year. Another research conducted by (Suharti et al., 2016) found that the total value of mangrove ecosystems in East Sinjai, Indonesia, with

total area of 758 ha, is about US $3,386/ha/year.Analyzing the benefit value of the mangrove resources shows that the indirect benefit has the highest value of 48.61 %, of total benefits, followed by direct benefit of 45.68%, bequest benefit of 4.57%, existence benefit of 1.08% and the optional benefit is shown to be 0.06 %. These results are in line with research results by (Baderan, 2013) conducted in Kwandang District, Gorontalo, (Lugina et al., 2019) in Kubu Raya, West Kalimantan, (Kalitouw et al., 2015) in Kulu village, North Minahasa, and Malik, (Malik et al., 2015) in Takalar, South Sulawesi where total value of indirect benefits outweigh that of direct benefits.

Table 3. Recapitulation of type and direct benefit of mangrove resource in on the coast of Bipolo village

Benefit Category	Benefit Value	Percentage (%)
Direct Benefit	IDR 159,412,371/ha/year or (US $ 10,899/ha/year	45.68
Indirect Benefit	IDR 195,403,961/ha/year or (US $ 13,361 /ha/year)	48.61
Optional Benefit	IDR 217,245/ha/year or (US $ 15/ha/year)	0.06
Existence Benefit	IDR 3,756,358/ha/year) or (US $ 257/ha/year)	1.08
Bequest Benefit	IDR 15,941,237/ha/year or (US $ 1,090/ha/year)	4.57
Total Economic Value	IDR 374,731,172/ha/year or (US $ 25,622/ha/year)	100

Source: Primary data analysis, 2020

According to (Suharti et al., 2016):

> "Ecological benefits derived from mangrove resource is greater than direct eco-nomic benefits. These values indicate that natural resources and the environment need a higher appreciation".

The results of this research should become the basis for developing policy options for poverty alleviation programs in Bipolo Village. The results from the analysis of total economic value of mangrove vegetation in Bipolo Village, which reaches IDR 374,731,172/ha/year or US$ 25,622 per ha per year, could be considered as the compensation fee paid by commercial industries that convert mangrove vegetation for commercial purposes. The compensation fee can be used by the local authority for man-grove restoration projects in Bipolo. According to (Susilo et al., 2017) "… in many regions of Indonesia, population pressure and urbanization as well as a conversion of mangrove areas into agriculture, industrialization, and coastal aquaculture are the driving factors threatening mangroves".

Local governments, being aware of the benefits of mangrove should develop policies to protect mangrove areas by charging all commercial activities along the coastline with a rational compensation fee. At the same time, compensation policies that could be developed for local communities, who have economic activities in and around man-grove vegetation, should involve them in conservation programs. (Susilo et al., 2017) found that people with economic activities in mangrove vegetation areas have higher incomes and are more willing to pay for mangrove restoration. Their results also revealed that those who have lower earnings were more willing to donate time than money for mangrove restoration. According to (Belay et al., 2020), the use of labor time as a payment vehicle is more appropriate than the use of money for conservation pro-grams because disposable income is low, especially for many in developing countries.

CONCLUSION

Based on the analysis of the benefits of mangrove, it might be concluded that: (i) the population in Bipolo Village has tended to increase over the last 5 years, causing the amount of arable land to decrease as productive land is converted for settlements, infrastructure and other economic activities, (ii) currently, there are two major companies that have established a modern salt industry in Bipolo Village with a production capacity of approximately 100 ton/ha/year. The two companies, in collaboration with the four landlords, established a large potential salt industry in 2016, which now occu-pies 2.64 ha for production activities; (iii) mangrove in Bipolo is now dominated by Ceriopstagal (32.45%), followed by Avecenniaalba (22.52%), Aegialitisannulata (22.52%), Sonneratia alba (11.92%) and Rhizophora apiculate (10.60%). Generally, there are 1,510 individual/ha which is dominated by Ceriopstagal (490 individu/ha) and followed by Avicenniaalba (340 individu/ha) and Aegialitisannulata (340 individu/ha); (iv) based on calculation of the benefit value of the mangrove resources, the results showed that the indirect benefit has the highest value of 58.68%, of total benefits, followed by direct benefit of 36.75%, bequest benefit of 3.68%, existence benefit of 0.87% and the optional benefit is shown to be 0.05%. These values indicate that natural resources and the environment need a higher level of appreciation, (v) the results from the analysis of total economic value of mangrove vegetation in Bipolo Village, which reaches IDR374,731,172/ha/year or (US $ 25,622/ha/year), could be considered as the compensation fee of commercial industries that convert mangrove vegetation for commercial purposes. This compensation fee could benefit the local authority for mangrove resto-ration projects in Bipolo Village.

AUTHOR CONTRIBUTIONS

Conceptualization, F.B and P. K; methodology, P.K.; validation, F.D, H.W. and A.N; formal analysis, H.W and A.N.; investigation, P.K; writing—original draft preparation, P.K.; writing—review and editing, A.N.; visualization, H.W.; supervision, F.D.; project administration, F.B. All authors have read and agreed to the published version of the manuscript.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

Appendix

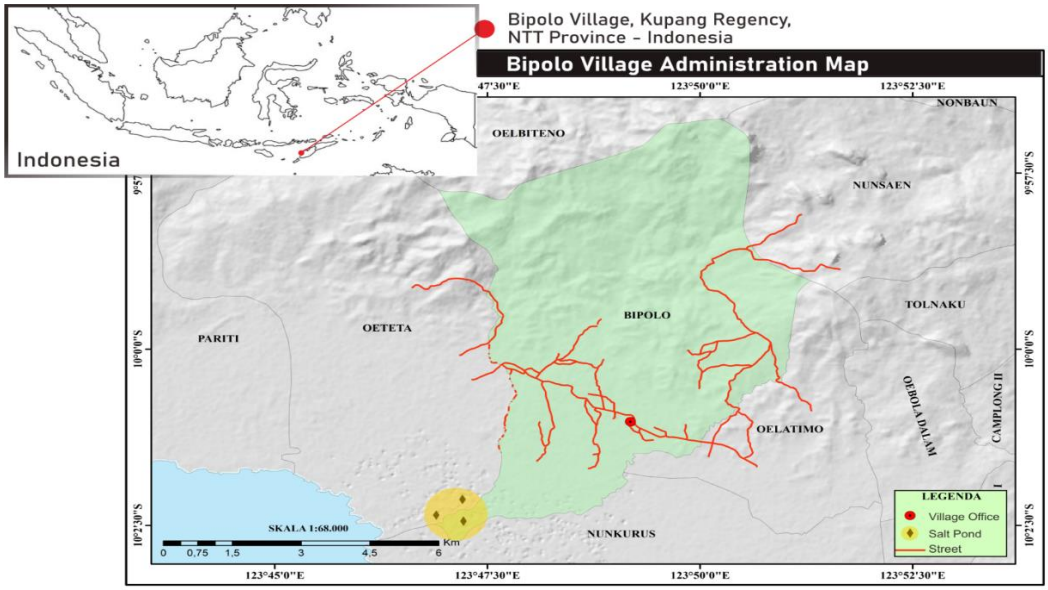
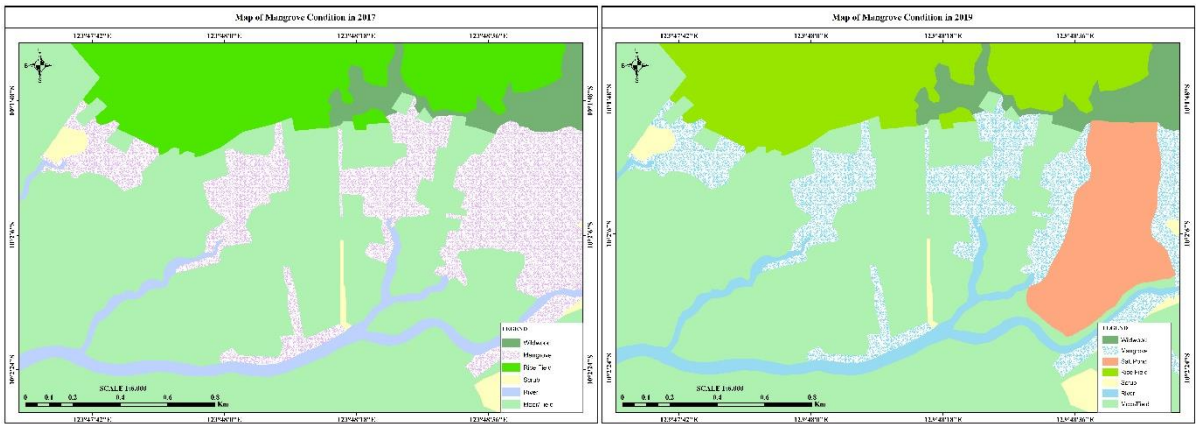


Figure 4. Bipolo Village Administration Map



(i) (ii)

Figure 5. (i) Satellite image of mangrove condition in 2017; (ii) Satellite image of mangrove condition in 2019

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