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Evaluation of Ecosystem Services and Mangrove Management Based on the Blue Economy Approach of Untung Jawa Island

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Abstract

Mangrove forests have a very important role for people's lives, especially for people who live in coastal areas, both from environmental, economic and social aspects. However, the economic potential of the ecosystem services provided by mangrove forests has not been comprehensively calculated. As a result, the economic potential of mangrove forests in an area is often calculated to be lower than the actual economic potential. The purpose of this research is to evaluate the total economic potential of mangrove forest ecosystem services. The economic valuation method of ecosystem services used in this study is the Total Economic Value method, including the economic value of providing services, regulatory services, cultural services, and supporting services. The location of this research is on Untung Jawa Island, Seribu Islands, DKI Jakarta Province, while the research time is from July to September 2022. The data used in determining the economic value in this study are primary data and secondary data. The results of the analysis show that the total economic value of the provision of services is around IDR 607 million per year, support services around IDR 15 million per year, cultural services around IDR 1.3 billion per year, and regulatory services around IDR 34 billion per year. The findings of this study have implications that the government and related stakeholders are required to provide more intensive education to the public about the importance of sustainable management of mangrove forests for the development of a blue economy on the island

Keywords: Total Economic Value, Ecosystem Services, Mangrove, Blue Economy, Untung Jawa Island

INTRODUCTION

In general, the literature acknowledges that mangrove forests have a very important role for mankind, especially for people who live in coastal areas. Besides being beneficial for human life, mangroves can also be beneficial for animals, the economy, society, and the environment. This is based on the understanding that mangrove forests have a variety of positive functions, including physical, chemical, biological, economic and tourism functions (Sujiwo et al., 2022).

Ecosystem services is a term used to describe the benefits people receive from an ecosystem, including mangrove, coral, forest, seagrass and peat ecosystems. This research focuses on the study of mangrove forest ecosystem services on Untung Jawa Island, Thousand Islands, DKI Jakarta Province.

Society can benefit from ecosystem services in a number of ways, both directly and indirectly, such as by using them as inputs in the creation of commodities and other services. The concept of ecosystem services is widely used in environmental economics, where the benefits of mangrove forests are converted into economic units so that these ecosystem services can be converted into currency values. Ecosystem services are divided into four categories, namely provisioning services, regulatory services, cultural services and supporting services (MEA., 2005).

Provisioning services are defined as products obtained from the ecosystem; for example, mangrove ecosystems can provide a variety of marine products (fish, shrimp, and crabs) and natural resources (firewood). Ecosystems also offer regulatory services, which include climate management, carbon sequestration, air and air purification, are advantages derived from controlling ecosystem processes and can undoubtedly contribute economically. Furthermore, cultural services are defined as non-material benefits derived from ecosystems, such as mangroves that can serve as ecotourism destinations and offer spiritual and aesthetic experiences, cultural heritage, recreation, scientific research, etc. While supporting services, such as nutrient cycling, pollination, and seed dispersal, are needed to support all other ecosystem functions (MEA., 2005).

Until now, the estimation of the economic value of mangrove forest ecosystem services still faces various obstacles, including the absence of market values for the various services provided by these ecosystems. This kind of condition is one of the challenges in assessing mangrove forest ecosystem services from an economic point of view. In addition, empirical research that focuses on estimating the economic value of mangrove forest ecosystem services as a whole is still limited (UNEP, 2011).

The notion of total economic value (TEV), on the other hand, is an economic concept used to determine the potential economic value of all the services provided by an ecosystem. TEV is the total value of all the economic potential embodied in provisioning services, regulatory services, cultural services and supporting services. However, it should be noted that some ecosystem service indicators have market prices while some other ecosystem service indicators do not have market values. One of the challenges researchers must face is determining the economic value of ecosystem service indicators that have no market value. To overcome this problem, the literature suggests using replacement prices in estimating the economic value of these ecosystem service indicators (Vo Quoc et al., 2012).

The literature review found that several researchers had carried out studies to calculate the economic value of mangrove forests in Java Island. For example, Indartik and Pribadi (2019) conducted a study on the economic value of mangrove forests in East Java Province. Their research divides the economic value of mangrove forests into two groups: economic values based on ecological functions and economic functions. However, their research only used three indicators of economic value based on ecological function and two indicators of economic value based on economic function.

Kurniawati and Pangaribowo (2018) carried out a study on the economic value of mangrove forests in West Java Province. Their research divides the economic value of mangrove forests into three groups: economic values based on direct benefits, indirect benefits, and optional values. In this case, their research includes five indicators to determine economic value based on direct benefits, includes one indicator to determine economic value based on indirect benefits, and one indicator of economic value based on option value.

In particular, Prasetiyo at al. (2016) conducted a study to calculate the economic value contained in mangrove forests on Untung Jawa Island, DKI Jakarta Province. However, their research only determines the economic value of mangrove forests on the island based solely on use value, without taking into account the non-use value of these resources. These previous studies have not comprehensively analyzed the economic

value of mangrove forests by including various dimensions and indicators of the economic value of mangrove forests, whether they have market value or those that do not have market value. These findings motivated this study to analyze the potential economic value of mangrove forests using the Total Economic Value (TEV) approach. Referring to UNEP (2011), this study argues that the TEV approach will produce estimates of the economic value of mangrove forests that are close to their real values. This is based on the notion that the estimated total economic value of mangrove forests will be based on the accumulated economic values of four types of ecosystem services provided by mangrove ecosystems: provisioning services, regulatory services, cultural services, and supporting services.

METHODS

This research method involves direct observation and literature review to assess the value of ecosystem services, especially mangrove ecosystem services on Untung Jawa Island, the Thousand Islands, Jakarta Province.

Study area

This research took place in the mangroves of UntungJawa Island, Thousand Islands, Jakarta. The research was conducted in July - September 2022 during 3 field visits during the dry and rainy seasons. The research time was taken either in the morning, afternoon or evening. UntungJawa Island has a land area of 40.1 ha with a potential mangrove area of 3.46 hectares. The types of mangroves found on UntungJawa Island are Rhizoporamucronata and Avicenia alba (Prasetiyo et al., 2016).

Data collection and sampling design

Both primary and secondary data are part of the needed data. Primary data is information gathered during field trips to UntungJawa Island from questionnaires, discussions with different parties, direct observation, and interviews. With regards to the sampling strategy for respondents utilizing Accidental Sampling or Convenience Sampling, i.e., data sampling methods or respondents whose number is not known in advance, as well as individuals who are met and in accordance with the criteria can complete the disseminated questionnaires. The researcher immediately collected data from the sampling unit that was encountered at the research location. (Kumaat, 2022).

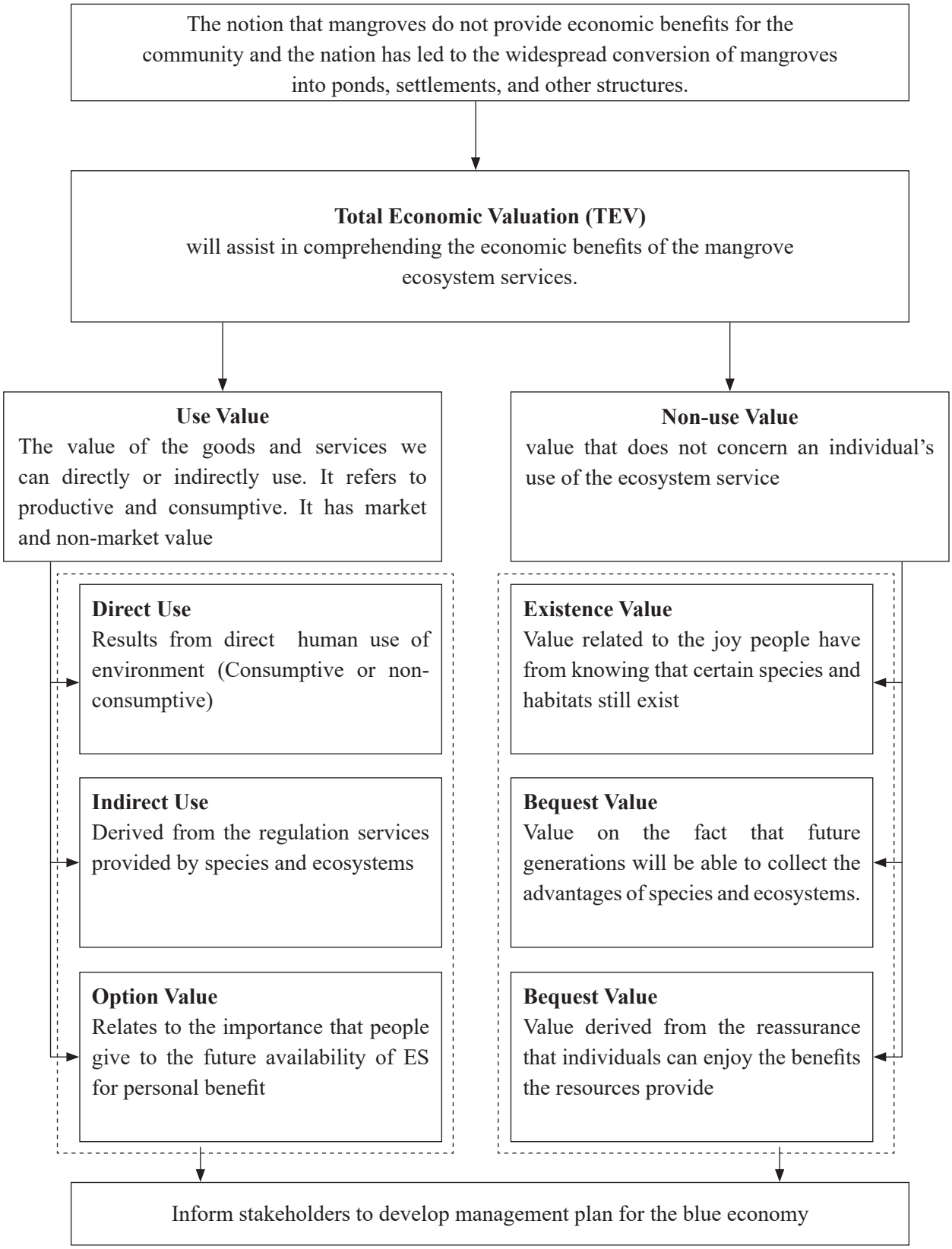
People from Untung Jawa Island who engage in everyday activities both directly and indirectly related to the mangrove forest are the study's respondents (mangrove seed farmers, craftsmen, fish seekers, fishermen) and tourists. Interviews were also carried out with stakeholders at the study area to find out the policies applied to the mangrove area and the general condition of the study area, such as the village head, the tourism agency, fishermen. Surveys and discussionswere also conducted with representatives from Ministry of Marine Affairs and Fisheries as well as withHNSI (Indonesian Fishermen Association) representatives in MuaraAngke in order to assess the fish, shrimp, and crabs production on UntungJawa Island. The interviewed stakeholders were responsible to record all the fish resources collected by local fishermen with small boats. The market price for fish resources were also derived from the local market in MuaraAngke. Meanwhile, secondary data was obtained by collecting supporting data from various peer review supporting literacy.

Economic assessment methodologies

This section gives a general overview of the theory and methods used to assess environmental products and services before delivering the summary findings on the economic value of ecosystem services. The Total Economic Valuation (TEV) is used as the economic valuation approach for mangrove in this study. In a study by Pascual (2010) emphasized that EV is categorized into use values and non-use values. Then, use value is split into three categories: direct value (goodsor services that can be consumed directly), indirect value (benefits that have a functional puIDRose), and option value (direct and indirect use value for the future generation). However, non-use values also include existence values, which are defined as the values of knowing how to live sustainably (Janekarnkij., 2008). Two

key ideas in environmental economics are TEV and ecosystem services concepts. In general, the process of determining economic value can further be explained through table 1.

Table 1. The relationship between TEV and ecosystem services for the decision makers to develop blue economy



Source: Pascual et al., 2010, modified

RESULTS

Economic value of provisioning services

For the purpose of this research, provisioning services refer to products obtained by the community from the mangrove ecosystem, such as food, fuel, and wood fiber. Mangrove forest provision services also refer to the benefits received by the community, due to the shelter of various living things; including fish, shrimp, and crab (Vo Quoc et al., 2012). The following is an economic valuation of mangrove forest provision services from the aspect of fish, shrimp, crab, and various types of wood breeding grounds.

Habitat for fish

Literature suggest that fish development is greatly influenced by mangroves, particularly in the early stages. The yellow snapper, or Lutjanus argentiventris, is a species of fish that depends on mangroves for its whole life cycle. When the juvenile fish reach a size of about 100 mm, they leave the mangrove habitat and go to deeper habitats. Fish exploit the highly complex mangrove forest ecosystems as adaptations to fend off predators and as food sources (Findra et al., 2016). Table 2 shows the various types of fish that require mangroves forest during their life cycle, including their catches and prices. As shown in Table 2, this study found that mangrove forest services as fish habitat have a high economic value, which is around IDR 263 million per year. The findings of this study are in line with previous studies which found that fisheries are an important indicator for determining the economic value of mangrove forests. For example, Indartik and Pribadi (2019) stated that fisheries in mangrove forests can reach around IDR 23 million per year while Kurniawati and Pangaribowo found that the economic value of mangrove forests as fish habitat can reach almost IDR 335 million per year.

Table 2. Types of commercial fish that require mangroves during their life cycle, catch and price

Scientific names	Common names	Price/kg	Catch/year	Total
Lutjanus argenti-ventris	ikan kakap kuning	35,000	1,200	42,000,000
Lethrinus harak	Ikan Lencam bintik hitam	25,000	1,296	32,400,000
Lutjanus lentjan	Ikan Lencam (Pane et al., 2020)	25,000	1,080	27,000,000
Lutjanus fulvi-flamma	Ikan dory snapper	30,000	3,600	18,000,000
Siganus sutor	Ikan Baronang	40,000	3,600	144,000,000
Total				263,400,000

Habitat for shrimp

Another important provisioning service of mangrove forests is as a shrimp habitat. According to Arief (2003), a variety of species use the mangrove habitat to locate food and shelter when they are young or juvenile. Others live continually throughout their life cycle in the mangrove ecosystem, for instance api-api shrimp or metapenaeus monocerosrequire mangroves during their life cycle because mangroves are places to find food, spawn or to shelter from predators. There is a positive and significant relationship between mangrove forests and the level of fishery production (Kordi, 2012). In April 2021, 10,549 clear lobster seeds were released into the waters of the Untung Jawa islands by the Ministry of Maritime Affairs and Fisheries.

The following is a list of shrimp requiring mangroves ecosystem during their life cycle and the total catch per year (Table 3). The research results as presented in Table 3 depict that the economic value of mangrove forests as a shrimp habitat is around IDR 129 million per year. This study found that giant prawns were no longer available on Untung Jawa Island and around Jakarta due to reduced mangrove areas in the Thousand Islands. Previous research also found that mangrove forests have a fairly high economic value. For example, Rospita et al. (2017) suggested that mangrove forests as shrimp habitats can achieve an economic value of around IDR 127 million per year while Kurniawati and Pangaribowo found that the economic value of mangrove forests as shrimp habitat could reach almost IDR 137 million per year.

Habitat for Crab

Furthermore, the literature generally acknowledges that mangrove forests have high potential as crab habitat (Ismail et al., 2019). The following is a list of crabs that need mangroves during their life cycle and their catch per year in (Table 4). As presented in Table 4, this study only found "wideng crab" species in the mangrove forest of Untung Jawa Island, Thousand Islands, while "orange mangrove crab" and large mangrove crabs were not found on the island. Furthermore, the results of the analysis show that the economic value of mangrove forests as crab habitat is around IDR 86 million per year. This value is slightly smaller than the findings of Rospita et al. (2019) who argued that mangrove forests as crab habitat can achieve an economic value of around IDR 91 million per year.

Table 3. Types of commercial shrimp that require mangroves during their life cycle and their prices

Scientific names	Common names	Price/kg	Catch/year	Total
Metapenaeus monoceros	Udang api - api	Rp 60,000	2,160	129,600,000
Macrobrachium rosenbergii	udang galah	Rp 50,000	0	0

Table 4. Types of commercial crabs that require mangroves during their life cycle and their prices

Scientific names	Common names	Price/kg	Catch/year	Total
Episesarma meder	Kepiting wideng	12,000	72,000	86,400,000
Scylla olivacea	kepiting-bakau jingga	145,000	0	0
Scylla serrata	kepiting-bakau besar	160,000	0	0

Producer of many products of economic value

The literature acknowledges that mangrove forests are an eco-system with the potential to provide various products of economic value to the community, including providing firewood and mangrove fruit which can be further processed. Firewood is one of the many goods that mangrove forests can provide.

Previously, many people on Untung Jawa Island used the mangrove forest to find firewood as cooking fuel. In addition, mangroves can produce a variety of additional processed products including chips, syrup, dodol, and others that can increase people's income (Sabana, 2015).

However, this study found that the people of Untung Jawa Island were not yet interested in processing mangrove fruit into processed products with higher economic value. The island community is more interested in utilizing mangrove fruit to become mangrove seeds. These seeds will grow into young mangrove trees which farmers will sell when there is a mangrove conservation program on this island. These young mangrove trees cost IDR 7,500 per tree. This research found that there are five mangrove farmers on this island. In a year there are about 17,000 trees planted. Thus, the total economy from selling mangrove trees can reach around IDR 127 million per year. This value is higher than the findings of Prasetyo et al. (2016) which determines the economic value of mangrove fruit at IDR 45 million per year.

Economic value of regulating services

Water regulation, purification, and waste treatment

Literature suggests that mangrove forests are an ecosystem that has high potential in providing regulatory services, especially in water regulation (Vo Quoc et al., 2012). Referring to previous research (Polii et al., 2020), determining the economic value of water management services from a mangrove ecosystem is carried out using a cost or community expenditure approach in fulfilling clean water for household needs. This value is considered equivalent to the function of mangrove forests as an intrusion barrier because if the area does not have mangrove forests, the community will have difficulty getting clean and fresh water. The survey results show that the population of the island of Untung Jawa is 2,440 people while the price of one gallon of water is IDR 3,000 per gallon. The following is the calculation of economic value of mangrove forests in terms of water regulation, purification and waste treatment. The results of the analysis show that the economic value of mangrove forests in terms of water regulation and intrusion barrier is IDR 20,305,680,000. This value is higher than the findings of Polii et al. (2020) which determines the economic value of mangrove forests in terms of water regulation and intrusion resistance of IDR 1,781,200,000 per year.

Economic value = TP x WC x P x days
TP = Total Population WC = Water Consumption
P = Price of Water (IDR/gallon) Days = Number of days in 1 year

So = 2,440 people x 7.6 gallons x IDR 3000 x 365 days
So = IDR 20,305,680,000

*One Indonesian consumes an average of 144 liters of water per day. 1 gallon is equivalent to 19 liters. So 144/19 = 7.6 gallons

Erosion control

In general, the literature acknowledges that mangrove forests have a significant role in preventing abrasion. Abrasion is a destructive oceanographic phenomenon due to erosion by waves and ocean currents. If this happens, damage will occur to the coastal environment including the mainland (Polii et al., 2020). In this case, determining the economic value of mangrove forests as abrasion prevention can be done using a replacement price approach, namely by building abrasion-resistant embankments. damage to settlements and housing and building facilities if the function of mangrove forests as a deterrent to abortion is damaged or lost (Indartik & Pribadi, 2019).

Based on the survey results and literature review, this study found that the length of the coastline of Untung Jawa Island which protects the mangrove forest is around 1,257 m (Prasetiyo et al., 2016). Meanwhile, the cost of making the embankment is around IDR 11 million per meter with a height of 7 meters and a width of 3 meters. Thus, the economic value of mangrove forests as an abrasion barrier is around IDR 14 billion. This value is equivalent to the findings of Indartik and Pribadi (2019) which determined that the economic value of mangrove forests as an abrasion barrier is IDR 12 to 27 billion. This value is different from the study by Polii et al. (2020) which determines the economic value of mangrove forests as an abrasion barrier of around IDR 211 billion.

Carbon sequestration and stock

Furthermore, the literature suggests that mangrove forests have economic value based on the fact that these ecosystems function as carbon sinks (Indartik & Pribadi, 2019). Therefore, the estimation of carbon storage in mangrove forests can be used as a basic reference in assessing the economic benefits of mangrove forests in the form of C-Sequestration environmental service commodities (Purnobasuki, 2012). The Paris Agreement, which Indonesia has ratified, calls for all countries to achieve carbon neutrality by 2050. The agreement aims to reduce carbon emissions and prevent climate change. One of the paths taken in reducing emissions and adapting to the effects of climate change is through preserving the functions of mangrove ecosystems, seagrass beds and brackish areas. The agreement makes mangrove forests an economic asset in the future (KLHK, 2016).

Referring to Barus and Wijaya (2021), this study determines the economic value of mangrove forests as carbon sinks based on the quantity of carbon that can be absorbed by mangrove forests on Untung Jawa Island, which can be multiplied by the carbon price. For the puIDRoses of this research, the carbon tax rate applied is the same as the carbon price in the international carbon market, which is IDR 30,000 per kilogram. Meanwhile, Windarni et al. (2018) estimate that the amount of carbon that mangroves can sequester is around 199 tonnes per hectare. The following is a model for determining the economic value of mangrove forests as a carbon sink. As seen, the results of the analysis show that the economic value of mangrove forests as carbon sinks is around IDR 20,615,718. This value is smaller than the findings of Hairunnisa et al. (2018) who determined that the economic value of mangrove forests as a carbon sink is around IDR 5.3 billion per year.

Economic value = amount of carbon absorbed by mangrove stands and litter x International carbon price x Mangrove area

carbon sequestration from mangrove stands
Economic value = 197.36 tons* / hectare x Rp. 30,000 X 3.46 hectares Economic value = IDR 20,485.968

carbon sequestration from litter
Economic value = 1.25 tons** / hectare x IDR 30,000 X 3.46 hectares Economic value = IDR 129,750

Total value = IDR 20,485,968 + IDR 129,750 = IDR 20,615,718

*Estimation of the amount of carbon that can be absorbed by the mangrove stand
**Estimated amount of carbon that can be absorbed by litter carbon

Cultural services

Cultural service is one dimension of ecosystem services provided by mangrove ecosystems. Cultural services refer to non-material benefits derived from mangrove ecosystems. There are four indicators that can be used to measure the cultural services of mangrove ecosystems: spiritual enrichment, aesthetic experience, educational development, and recreation (Vo Quoc et al. 2012). Based on field surveys and the constraints that must be faced, this study focuses on two indicators of mangrove forest cultural services, namely the development of education and recreation. The following is an estimate of the economic value of mangrove forest cultural service indicators in terms of education and recreation development.

Ecotourism

Traveling in a mangrove forest is one of the reasons for tourists to visit Untung Jawa Island. The travel cost method is all costs incurred to go to the mangrove ecotourism area. Indeed, as found in the literature, mangrove forests have high economic potential as providers of ecotourism services. Untung Jawa Island is one of the islands and tourist destinations in the Thousand Islands Regency which offers various types of beach tourism and mangrove forests (Prasetiyo et al., 2016).

Referring to Kurniawati and Pangaribowo (2017), this study uses the Travel Cost approach in estimating the economic value of mangrove forests as a tourist destination on Untung Jawa Island. Based on this method, there are three variables used to estimate the economic value of mangrove forests as a tourist destination: round-trip boat ticket prices from the port of Tanjung Pasir to Untung Jawa Island, the number of visiting tourists, consumption of tourists during their visit, MSME income, and lodging costs. Using the price of a boat ticket back and forth from Tanjung Pasir harbours to Untung Jawa Island is IDR 43,000. Based on the survey results, this study found that the number of tourists visiting Untung Jawa Island could reach 10,000 people per day, especially on weekends.

The results of the analysis show that the economic value of mangrove forests as a tourist destination is around IDR 430 million per year. This value is greater than the findings of Kurniawati and Pangaribowo (2017) who determine the economic value of mangrove forests as a tourist destination of around IDR 2.1 million per year. The price for renting accommodation is around IDR 200,000 to IDR 350,000 per night. There are around 15 lodgings on Untung Jawa Island consisting of various types of rooms and facilities and 123 SMEs that provide various kinds of food, drinks, clothing, snorkeling, bicycle and toilet rentals.

Research and education

The literature suggests that education and research are indicators of cultural services from mangrove forests (Vo Quoc et al. 2012). However, to the knowledge of researchers, no one in Indonesia has estimated the economic value of mangrove forests as a provider of cultural services in terms of educational and research development. This kind of condition is also expressed in the literature which suggests that cultural services are a dimension of ecosystem services that have not been fully disclosed and understood in depth. This is based on the insight that the economic value of these indicators is based on individual and emotional values, not based on market values. Consequently, there is little research on mangrove ecosystems that explicitly establishes the economic value of the cultural services provided by these ecosystems (Himes-Cornell et al., 2018).

Referring to Himes-Cornell et al. (2018), this study uses the monetary value of grants, salaries, and field and research costs. Based on a literature review, this study found that many studies have been conducted to examine mangrove ecosystems in terms of their conservation and biodiversity. This study assumes that research funding assistance from the Ministry of Education and Culture is around IDR 20 million per study. Based on researchers through Google Scholar, it was found that the number of studies that focused on the economic valuation of mangrove forests was 45 studies. Thus, research determines the economic value of mangrove forests on Untung Jawa Island as a provider of cultural services is around IDR 900 million per year.

Supporting services

Photosynthesis

Oxygen production is one of the most common but under-researched benefits of mangroves. We can calculate the economic value of this service from the amount of net oxygen that can be produced by mangroves. 5.9 tonnes of net O2 released per 1 hectare of mangrove per year. There is 3.46 hectare of mangroves so it means that it can produce 20,414 tonnes of net O2 produced or equal to 57.80 m3 on UntungJawa Island.

Economic value = total net O2 produced in m3 x the price of 1 m3 of oxygen cylinder Economic value = 57.80 m3 x Rp 30,000
Economic value = IDR 1,734,000

Soil formation and retention

The change in the coastline on UntungJawa Island due to abrasion is 21.77 m2. While the change in coastline by accretion is 45.32 m2 (Setiyowati., 2016). Then there is an addition of land surface of 23.55 m2. The price of land on Untung Jawa Island is Rp 600,000/meter.

of damage in the event of a storm, producing natural oxygen, and converting mangrove forest land into ponds. The instruments used were questionnaires and direct interviews with people living on the coast of the island.

The results of the analysis show that the

Economic value = (accession – abrasion) x land price/meter
Economic value = 23.55 m2 x IDR 600,000 = IDR 14,130,000

Provisioning of habitat and biodiversity

Optional benefit assessment refers to the biodiversity value of the mangrove ecosystem. The economic value used refers to Ruitenbeek (1992) in Teluk Bintuni, West Irian, which is US$ 15/ha/year or the equivalent of IDR 235,593/ha/year.

Mangrove social aspect

Understanding of mangrove ecosystem services in the community

In addition to estimating the economic value of the ecosystem services provided by mangrove forests on Untung Jawa Island, this research also seeks to measure the understanding of the community towards the ecosystem services provided by mangrove. For the purpose of this study, there are four indicators used to measure people's understanding of mangrove ecosystem services: erosion prevention, reducing the impact

majority of respondents (78%) understand that mangrove forests have an important function in preventing erosion. Respondents generally also understand that mangrove forests have a high role in reducing the impact of damage in the event of a storm/tsunami (78%). For oxygen-producing services, the survey results indicate that 50% of respondents understand that mangrove forests are ecosystems that produce natural oxygen. Furthermore, this study found that as many as 32% of respondents stated that they agreed if part of the mangrove forest land was converted into shrimp or fish ponds; as many as 29% of respondents stated that they did not agree; as many as 22% of respondents stated that they were in doubt; and as many as 16% of respondents stated that they were not sure. Figure 1 below shows the distribution of respondents' answers for the conversion of part of the mangrove forest land into ponds on Untung Jawa Island.

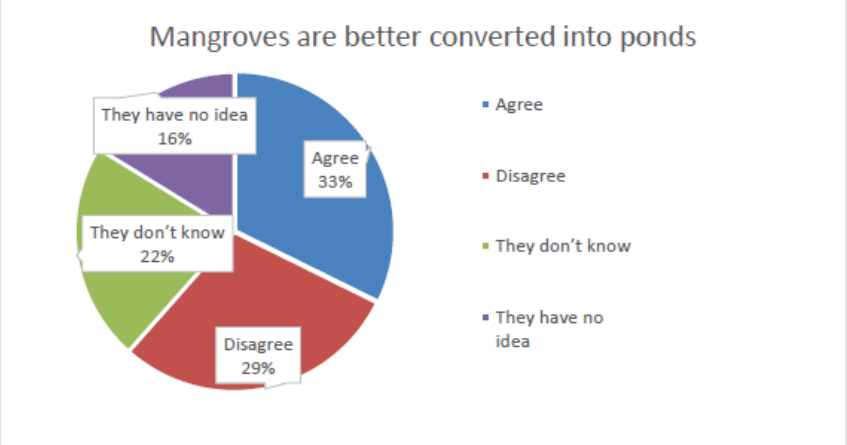


Figure 1. Results of analysis of respondents' opinions on the conversion of mangroves into ponds

The findings above have implications that the government and related stakeholders are required to provide more intense education to the public about the importance of managing mangrove forests in a sustainable manner. Furthermore, this research also seeks to explore the understanding of the people of Untung Jawa Island regarding the potential of mangrove forests as an ecotourism destination. The survey results indicate that the majority of respondents (77.4%) are of the view that mangrove forests have high potential as a beach tourism destination. Such an understanding shows that mangrove forests have high potential as part of the blue economy development on the island.

Finally, this study seeks to explore the understanding of the people of Untung Jawa Island about the relationship between mangrove forests and carbon trading. The survey results, as presented in Figure 2, indicate that the majority of respondents (74.2%) do not know that there is a close relationship between mangrove forests and global carbon trading. These findings have implications that the government and related stakeholders are required to provide more intense education to the public about the economic potential of mangrove forests from carbon trading.

DISCUSSION

The current status of mangrove ecosystem services

This study aims to determine the economic value of mangrove ecosystem services on Untung Jawa Island, Thousand Islands, DKI Jakarta Province. To the researchers' knowledge, only one study has attempted to determine the economic value of mangrove forests on Untung Jawa Island (Pratiyo et al., 2016). This study estimates the economic value of mangrove forests based on direct use values (timber benefits, fish benefits, and fruit benefits) and indirect use values (mangrove economic values as abrasion barriers, places to find food, recreation, education, and conservation). Based on aggregate calculations, the findings of this study yielded a total economic value of mangrove forests on the island of around IDR 7.8 billion per year. This research considers that this value does not yet reflect the actual total economic value of mangrove forests because it has not taken into account various indicators of other ecosystem services. This research seeks to find a more precise total economic value of mangrove forests on the island by taking into account various indicators of provisioning services, supporting services, cultural services,

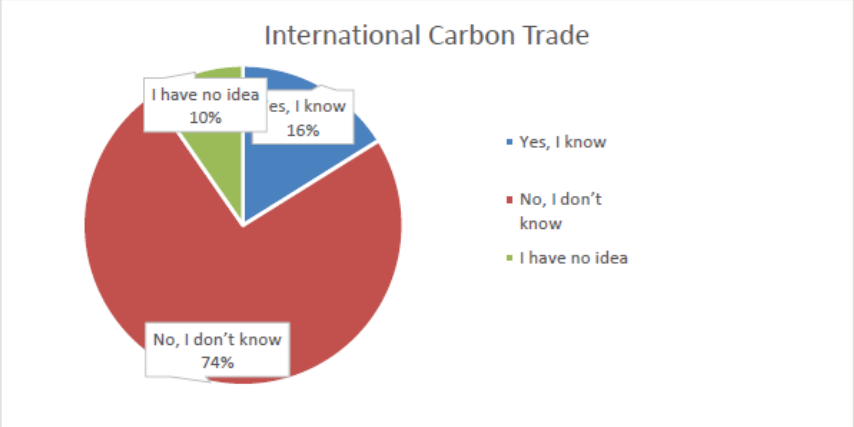


Figure 2. Level of knowledge of respondents related to international carbon trading

and regulatory services.

This research also seeks to enrich understanding of the economic value of mangrove forests in Indonesia by disaggregating the values of each indicator used in this study. This is based on the premise that many previous studies did not fully explain how these studies determine economic valuation estimates. For example, many of these studies do not describe the names of the fish, crab, and shrimp species that might be found. To overcome this, this study conducted direct interviews with the coordinating chairman of the Indonesian Fishermen's Association regarding the price and amount of their catch. Ecosystem services can also be quantify by implementing Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) modelling that can calculate several ecosystem services, including carbon sequestration, ecotourism, coastal protection (Tussadiah et al., 2021).

Total economic valuation

The results of the analysis, as explained in the previous chapter, explain that the total economic value of mangrove forests on Untung Jawa Island is around IDR 36 billion per hectare per year. Of the total economic value, the highest proportion of economic value is the economic value of regulatory services. The results of the analysis show that the economic value of regulatory services is around IDR 34 billion per hectare per year. The value of embankment construction along the shoreline of Untung Jawa Island as a substitute for mangrove forests is the most significant economic value of the economic value of mangrove forests as a barrier to abrasion and erosion. This finding implies that all stakeholders are required to have a correct understanding of the importance of conserving mangrove forests on the island. Furthermore, so far research related to the evaluation of mangrove ecosystem services has not evaluated the function of mangroves as a carbon sink which can become an asset for international carbon trading in Indonesia. Table 5 describes the ecosystem services that were not evaluated in this study.

Table 5. Ecosystem services not evaluated in economicsand alternative economic valuations

Ecosystem services not evaluated	Alternative economic evaluation
Provisioning services The function of mangroves is as a provision of genetics, ornaments and biochemicals	Several types of traditional medicine use processed materials from mangroves. In addition, mangrove wood was also used as cremation wood. So that the use of market prices can be used in evaluating these services.
Regulating services The function of mangroves is to regulate water quality, regulate pollination, tsunami moderation	Moderation of the impact of the tsunami can be evaluated economically by using the regional repair budget due to natural disasters which reaches up to 10 trillion from funds from BNPB (National Disaster Management Agency) and death compensation funds for heirs due to natural disasters by the social ministry of 15 million per person

Cultural services The mangrove adds to the aesthetic valueas well as Cultural heritage, spiritual and religious value of mangrove	Mangroves are not used as a cultural heritage site on Untung Jawa Island. Unlike in Bali where there are many Hindu temples located in mangroves. So that the Willingness to pay approach can be carried out in Bali compared to this research location. A hotel will be built on the island close to the mangroves. The price of a hotel lies not only in the facilities offered but also depends on the view the hotel has to offer. Tourists will pay more for the position of the room facing the beautiful mangrove scenery. So the price of the hotel will be worth more if there is a view of this mangrove. So that mangroves can make the location of a hotel or recreation area more economically valuable to attract tourists to stay there.So revenue from a hotel that is located facing mangroves can be used as an alternative methodology

In addition to providing production services with high economic value, mangrove forests on Untung Jawa Island also have an important role in providing a place for various species of fish that have high commercial value in the market. Table 6 presents the total economic value of each of the mangrove forest ecosystem services studied in this study.

Table 6. Summary of the economic valuation of each ecosystem service

Provisioning Services	**Economic Value**	**Percentage**
Fishing area	Rp 263,400,000	43.40%
Shrimp catch area	Rp 129,600,000	21.36%
Crab catch area	Rp 86,400,000	14.24%
Mangrove products	Rp 127,500,000	21%
Total	Rp 606,900,000	100%
Regulating Services	**Economic Value**	**Percentage**
Water regulation and purification	Rp 20,305,680,000	59.46%
Erosion control	Rp 13,825,020,000	40.48%
Carbon sequestration	Rp 20,615,718	0.06%
Total	Rp 34,151,315,718	100%
Cultural Services	**Economic Value**	**Percentage**
Ecotourism	Rp 430,000,000	32.33%
Research and Education	Rp 900,000,000	67.67%
Total	Rp 1,330,000,000	100%

Supporting Services	Economic Value	Percentages
Photosynthesis	Rp 173,400	1.15%
Soil Formation	Rp 14,130,000	93.46%
Biodiversity	Rp 815,151	5.39%
Total	Rp 15,118,551	100%

TEV methodologies

Table 7 describes several choices of TEV methods for evaluating ecosystem services. One ecosystem service can use several different methods. This research also shows that regulatory services have the most challenges in evaluating them into economic value because they require a lot of knowledge to quantify them.

Table 7. Ecosystem Service evaluation method

Economic Valuation Methodologies									
Ecosystem services	**Production Method**	**Substitute Method**	**Indirect Cost**	**Preventative expenditures**	**Change in earnings methods**	**Hedonic method**	**Travel Cost Method**	**Willingness To pay**	**Benefit-transfer method**
Provision services									
Fishing Area	x								
Shrimp catch area	x								
Crab catch area	x								
Mangrove products	x		x						
Provide genetics		x						x	
Provide ornament	x								
Biochemical processess		x	x					x	
Regulation Services									
Air Quality maintenance								x	
Climate regulation								x	

Water regulation, puricifaction and waste treatment		x		x			x	
Erosio control				x				
Moderation of Tsunami and storm				x				
Disease regulation				x	x		x	
Carbon sequestration ponds	x							
Natural source of food		x						
Cultural Services								
Ecotourism	x					x	x	
Aesthetic Value					x		x	
Cultural Heritage, Spiritual & Religious Value							x	
Research and Education	x							
Supporting Services								
Photosynthesis	x							
Soul Formation	x							
Biodiversity								x

Table 8 explains further regarding the definition of the TEV methodolgies in evaluating ecosystem services into economic aspects.

Table 8. Definition of economic valuation methodologies (Modified, Lal P., 2003)

Methodologies	Definitions
Production method	It is for goods and services are traded on the market, and their economic value can be calculated
Substitute method	The price of comparable products, or near equivalents, sold in the market can be used as a proxy for market price for goods and services that are not marketed, such as dyes and medicinal values.
Indirect opportunity cost	A proxy for the cost could be the time spent collecting and preparing dyes or medications.
Preventative expenditures	This approach is used to estimate the economic value by determining how much replacement cost need to pay once goods and services lost. For example, after mangroves are reclaimed, one may need to establish a seawall to prevent the erosion or a solid-waste filtering device to get clean or pollutant free water.
Change in earnings methods	The economic cost of pollution is estimated using the loss in earnings approach due to medical expenses when human health is affected by pollution. However, it fails to account for the full cost of pollution to society, which includes the possibility of human loss. Utilizing the insurance premiums that people are willing to pay, the value of human life is calculated.
Hedonic method	This method relies on people's willingness to pay for a good, which often depends on its characteristics. Thus, for example, the price that is paid for a house not only depends on its size, but also on its location, e.g. whether it is in a highly polluted area, or near an industrial site where there is excessive air pollution. Economists use such information to determine the economic value of, for example, air pollution, or environmental aesthetics.
Travel cost method	The recreational and aesthetic value of mangroves could be estimated using how much people are willing to pay to visit a site. Note that this method relies on the actual expenses incurred by the recreational user to derive a market demand for the resource and from which an appropriate economic value for the recreational experience is estimated. The actual expenditure itself is not equal to the economic value of recreational experience.

Benefit-transfer method	Where all else fails, benefit-transfer estimates have been argued by some to offer potential to estimate economic values. Benefit transfer is effectively using values estimated from previous economic studies conducted elsewhere and applying them to current sites. It is important, however, to note that care needs to be taken when using this approach. It is important to ensure that, when using value estimates derived for other sites, there is close similarity between the characteristics of the two sites and the respective policy environments. In addition, there must be sufficient similarity in the stages of economic development, and the supply and demand conditions.
InVEST Modelling	Integrated Valuation of Ecosystem Services and Tradeoffs modelling that can calculate several ecosystem services, including carbon sequestration, ecotourism, coastal protection (Tussadiah et al., 2021)

CONCLUSION

The literature review found that several researchers have carried out studies to estimate the economic value of mangrove forests in Indonesia. In particular, there is one study that has attempted to establish the economic value of mangrove forests on Untung Jawa Island. However, the results of previous studies have not reflected the actual total economic value of mangrove forests because they have not taken into account various indicators of the four ecosystem services.

This research seeks to enrich the understanding in the literature about the economic value of mangrove forests by finding a more precise total economic value of mangrove forests on Untung Jawa Island. This is done by taking into account various indicators of provision services, support services, cultural services, and regulatory services in estimating the total economic value of mangrove forests on the island. The results of the analysis show that the total economic value of the provision of services is around IDR 607 million per year, support services are around IDR 15 million per year, cultural services are around IDR 1.3 billion per year, and regulatory services are around IDR 34 billion per year.

The findings of this study provide several implications that need attention. First, the government and related stakeholders are required to provide more intense education to the public on the importance of managing mangrove forests in a sustainable manner. Second, the government and related stakeholders are required to provide more intense education to the public about the economic potential of mangrove forests from carbon trading. Third, all stakeholders are required to have a correct understanding of the importance of conserving mangrove forests on Untung Jawa Island.

This research has provided deeper insight into the total economic value of mangrove forests which is more precise on Untung Jawa Island. However, the research also has some limitations. First, this research has not taken into account all indicators of mangrove forest ecosystem services identified in the literature, especially cultural services and provision of mangrove ecosystem services. Second, this study only discusses the total economic value of mangrove forests on Untung Jawa Island. The results obtained may differ from the results of research on other islands. Third, this study does not compare all possible approaches or methods to be used in calculating the total economic value of mangrove forests, especially for indicators that have no market value.

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