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# Management strategies for the potential and value of mangrove forest ecosystem services in the Panango area of south Bolaang Mongondow regency

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## Abstract

The Panango area is an area that has mangrove forests in its coastal areas that are used for ecotourism, fisheries, and environmental conservation. Mangrove forests in the area have the potential and value of important benefits to the surrounding community which has been using them for a long time, but data and information are not yet available, so it is necessary to identify and assess the ecosystem services in the area. The purpose of this study was to determine the potential and value of the benefits of mangrove ecosystem services in the Panango area in terms of provisioning, regulating, cultural, and supporting functions, and to determine strategies for managing the mangrove forest in the area. This research uses primary data obtained through field observations, namely observation of research objects, completion of questionnaires, and interviews with respondents. Secondary data was obtained from local government data and other data sources relevant to the research. The research data analysis technique was carried out by calculating the total economic value of each mangrove ecosystem service and SWOT analysis to determine mangrove area management strategies. This study concluded that the economic value of the potential and benefits of mangrove forest ecosystem services in the Panango area in total Rp. 26,259,380,092/year consisting of the value of service providers of Rp. 684,300,000/year, the potential for regulatory services as a wave breaker with a benefit value of Rp. 9,705,300,000/10 years, the potential value as a cultural service of Rp. 15,846,000,000/year, and the potential value as a supporting service of Rp. 23,780,092/year. Strategies that can be used in sustainable management of the potential and value of the benefits of mangrove forest ecosystem services in Panango area are through conservation efforts to protect and manage the area by involving joint participation between local governments and communities and other stakeholders.

**Keywords:** Management Strategies; Mangrove Forest Ecosystem; Ecotourism.

## 1. Introduction

The Panango area is an area built with the concept of combining an office area with ecotourism, fishing, and conservation areas. The Panango area is complete as it contains the office center of the South Bolaang Mongondow Regency Regional Government, ecotourism sites, and community-owned fishing facilities.

Topographically, the Panango area is a small bay with mangrove areas surrounding the shoreline. Most of the mangroves in this area are still in good condition and some have been converted into plantation areas. The plantation area existed before the construction of the office area of South Bolaang Mongondow Regency.

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The existence of mangrove ecosystems in the Panango area has provided important benefits to the local community. Local communities have used certain parts of mangrove plants for medicinal purposes, food, building materials, and preservatives and dyes for fishing nets.

Mangrove ecosystems contribute to the fertility of surrounding waters by providing nutrients from the decomposition of organic matter, particularly in the form of nitrites and nitrates. In addition to being a habitat for various benthic organisms, especially mollusks and snails, this ecosystem is also used as part of the life cycle of certain species of fish and marine organisms. In addition, dense stands of mangrove trees physically shield coastal areas from wave action, seawater intrusion, and abrasion (Djamaluddin, 2018).

Mangrove forests provide economic, ecological, and social functions. The economic functions that exist in mangrove forests are the production of household needs, the production of industrial needs, and the production of seeds. The ecological functions are protecting the coastline, preventing seawater intrusion, and providing habitat for various bird species (Kustanti, 2011). Mangroves are socially renewable resources that have provided various functions that can be used for the survival of coastal communities. The management of mangrove forest ecosystems is important in the pursuit of environmental conservation in coastal areas (Utomo, et al., 2017).

Mangrove areas in South Bolaang Mongondow Regency are understood by the community as protected forest areas, so in general, mangroves in this area are better conserved because the right to control mangrove areas is less likely for individuals (Damanik et al., 2012). Along with the development of regional development, it has had an impact on reducing the area of mangroves. This condition occurs in mangrove ecosystems, especially those in the Panango area. This area has experienced development as a regional office center with the construction of office facilities and infrastructure for regional apparatus organizations.

The problem of development in the Panango area is very dilemmatic. On the one hand, development must continue, but on the other hand, the mangrove ecosystem must be preserved. Therefore, an appropriate management strategy is needed. Management strategies can be implemented if they are supported by the availability of accurate data. Considering the current state of the Panango area, it is considered necessary to research possible management strategies and the value of environmental services for sustainable development and use by the surrounding community. The results of this study are expected to be used as a basis for the future development and management of mangrove ecosystems, especially in the Panango area, in a sustainable manner, considering that mangrove ecosystems have very important roles and benefits for humans.

## 2. Methods

This research uses primary and secondary data. Primary data was collected directly through field observations, interviews, and the distribution of questionnaires to respondents who were considered to have an interest in the use of the area and policymakers. Secondary data was obtained from data on fishermen in Tabilaa village and Linawan village and the South Bolaang Mongondow Regency Fisheries Service. Data on the area of mangrove forest and the list of unit prices of commodities were obtained from the Regional Research and Development Planning Agency (Bappelitbangda) and the Public Works and Spatial Planning Office (PUPR) of South Bolaang Mongondow Regency. Other secondary data were obtained from writings and data sources relevant to the research. The observation method was used to facilitate the identification of ecosystem services in the research site. The ecosystem services are based on four types of services, namely provisioning services, regulating services, cultural services, and supporting services (MEA, 2005). The data obtained were then used to calculate the total economic value of each identified ecosystem service of the mangrove forest. In addition, a description of the study object was also carried out to map the ecosystem services based on the data and facts obtained from the research results. Quantitative descriptive techniques were used to analyze the research data.

The identification of mangrove ecosystem services aims to obtain a mapping of the components of provisioning, regulating, cultural, and supporting services. The data used in the analysis of the economic value of the mangrove ecosystem are the results of field observations, primary data analysis, and secondary data analysis. After obtaining data on the potential and value of the benefits of these ecosystem services, the strategy for managing the Panango area mangrove forest is determined. The SWOT analysis method is used to determine the strategy.

## 3. Results and discussion

### 3.1. Potential and Beneficial Value of Provisioning Services

The results of the data analysis from the completed questionnaire for this study showed that 83% of the respondents reported that the Panango mangrove forest provides benefits as a service. The direct beneficial value is the value or benefit of mangrove forest resources that are directly used through their production and consumption.

The results of the analysis of mangrove ecosystem provisioning services that are directly used by the community include nipah, fish, mollusks, and medicines. Anggraini et al. (2017) have reported in a study of ecosystem services in Rembang Regency that the mangrove ecosystem provides food for the surrounding community as a service for oysters, crabs, and worms. Takarendehang et al. (2018) conducted a study on the benefits of mangrove forests in Southeast Minahasa Regency and found that there are fish services. The following is the utilization of provisioning services by the community.

### 3.2. Nipah (*Nypa fruticans*)

Nipah (Nypa frulticans) belongs to the palm family. The local people call this plant Bobo. Nipah trees have unique morphological features. The branches of the tree are underground, only the leaves and bulbs can grow above the branches (Noor, et al., 1999). Some fishermen in Tabilaa and Linawan villages have long used *nipah* leaves as roofing material for their houses. Nipah leaf roofs are called *katul* by the local community. All the raw materials for the *nipah* leaf roof are obtained from the forest area.

Based on the results of the research, it was found that the results of making Nipah roofs are partly for their own use and partly for sale. Nipah roofing activities are not routinely carried out by fishermen daily but are adapted to the needs or demands of the fishermen. The number of fishermen found using *nipah* to make roofing materials was 2 persons.

Generally, each fisherman collects Nipah leaves every two months and can make Nipah roofs an average of 200 sheets per production, so in total, he can produce 1,200 sheets/fisherman per year. The selling price of Nipah Roof is Rp. 4,000/sheet, so the value of Nipah Leaves from each fisherman is Rp. 4,800,000/year or the total benefit value is Rp. 9,600,000/year. For the production cost of the material, there is no cost (zero rupiah) because all materials are taken directly from nature.

The production process from the time of manufacture until the roof is ready for use or sale takes an average of one week if the sun shines all day. The durability of Nipah roofs against damage during use is about 3 to 4 years of use. Generally, fishermen use this Nipah roof because it is cooler and suitable for use in coastal houses and the price is cheaper and more affordable.

According to Tabba, et al. (2015), Nipah is traditionally used as a roofing material, which has the advantage of providing cool temperature conditions in the house and tends to be durable as it does not corrode due to the influence of seawater like tin roofs. In addition to its use as a roofing material, it is also used to make woven handicrafts for traditional hats and traditional food packaging. Based on observations, some fishermen's houses have used thatched roofs made from the leaves of the sago tree. This plant is commonly found in the swampy areas around the village. In general, thatched roofs have been used as a substitute for *nipah* roofs because they are larger, more durable, and more weather resistant. In addition to the thatched roof, the average fisherman's house now has a tin roof.

### 3.3. Fish

The shady location of the bay is used by local fishermen to place their fishing gear in the form of a *bagan*. The number of nets found at the site amounted to 25 units. Owners and worker fishermen carry out fishing activities by staying in the *bagan* throughout the night with the use of lighting lamps aimed at collecting fish. The fishing process begins at dawn by lifting the net when the fish have collected in the net. The *bagan* catch consists of small fish such as *teri*, sardine, *tongkol,* and other species. The *bagan* catch is then sold to fish collectors or *tibo-tibo* in *sahara* size (25 kg bucket).

Fishing activities in Bagan have 2 patterns that are separated periodically. Fishermen explained that fishing in Bagan is divided into two fishing seasons, namely the fishing season for 9 months and 3 months.

For a fishing season of 9 months, the effective fishing time follows the lunar cycle during the dark moon and new moon with an estimated 8 days. Wet production in each *bagan* averages 100 kg/month. The prevailing price at Tibo-tibo collectors is Rp. 6,000/kg, so the production value in one month is Rp. 600,000/month. With an operating cost of Rp.

400,000 for 8 days, the net income value of each Bagan is Rp. 200,000/month or Rp. 1,800,000/year. So, the total usage value of 25 Bagan units during this season is Rp. 45,000,000/year.

For a 3-month fishing season, usually in August, September, and October. In this season, fishermen can produce a larger amount of catch. This is because these months are the white fish (anchovy) season. During this season, the effective time used by the fishermen in catching fish is 6 days a week or 24 days a month without exception when the moon is visible in the sky or full. The average production during this fishing period is 50 Sahara or 1,250 kg/month. This means that in 3 months, Bagan fishermen can catch an average of 3,750 kg. With the prevailing price at the collector (*tibo-tibo*) of Rp. 6,000/kg, the yield can be calculated at Rp. 22,500,000 in a year for this season. If this value is reduced by the daily operating costs of Rp. 50,000/day or Rp. 1,200,000/month or Rp. 3,600,000/year, the net income value of each card in this season is Rp. 18,900,000/year. This can be interpreted as the utilization value of 25 *bagan* units in this season is Rp. 472,500,000/year.

Fish catches from *bagan* are sometimes not only sold in wet form but some are dried by fishermen to be sold for Rp. 40,000/Kg. Based on interviews, one wet *sahara* can usually produce 4 kg of dried fish. From an economic point of view, this dried fish product is more profitable.

Based on observations, in addition to fishing with *bagan* fishing gear, fishermen usually also conduct fishing activities in the bay of the area. The types of fish caught are pelagic and demersal fish, such as *kuwe* or *bobara*, grouper or *goropa*, *biji nangka* or *lumotu*, and other varieties. Fishing activities are carried out by fishermen during their stay in *bagan*. The catch is also calculated according to the 9-month and 3-month fishing periods.

The average catch during the 9-month fishing season is 1 kg per day. In addition to consumption, part of the catch is sold at Rp. 40,000/kg. In one month, the fishermen produce a catch of 8 kg (Rp. 320,000) without production costs. Production costs are ignored because fishing is done at the same time as fishing in *bagan*. Thus, the fish provider service for the fishing catch of 25 *bagan* in a 9-month fishing season comes to Rp. 72,000,000/year.

The effective time for the 3-month fishing season in a month is 24 days, so if you add up the total fishing days for 3 months, it is 72 days. This means that fishermen can collect 72 kg during the fishing period. With a price of Rp. 40,000/kg, the average production of fishing rods in this fishing season is Rp. 72,000,000/year.

The results of the fishermen's recreational fishing activities using fishing rods during the 9-month and 3-month fishing seasons show similar results and are relatively higher than the *bagan* catch in the 9 months. These results illustrate that the value of the benefits of this fishing activity needs to be increased to increase the economic value obtained by the fishermen.

### 3.4. Mollusks

Mollusks, or what people call *bia*, are widely distributed in the mangrove forest of Panango area. Mollusks have high adaptability to different habitats, can accumulate heavy metals without dying, and act as environmental indicators. In addition to their role in the food chain cycle, there are also species of mollusks that have important economic value, such as various species of shellfish and various species of snails. Mollusks have several benefits for humans, such as a source of protein, animal feed, industrial materials, fertilizer materials, jewelry, and medicines (Dibyowati, 2009 in Wahyuni, 2016). Some species of *bia* found in the Panango area include:

*Bia Pece*, *Luwao* or Luawo. This mollusk is a type of shellfish that fishermen catch by digging in the mud where many mollusks hide. The shells of these mollusks are often processed into lime by burning and then crushed into a fine powder. Lime can be used as a preservative for corn on the cob. On certain traditional occasions, lime is chewed with betel nut and areca nut.

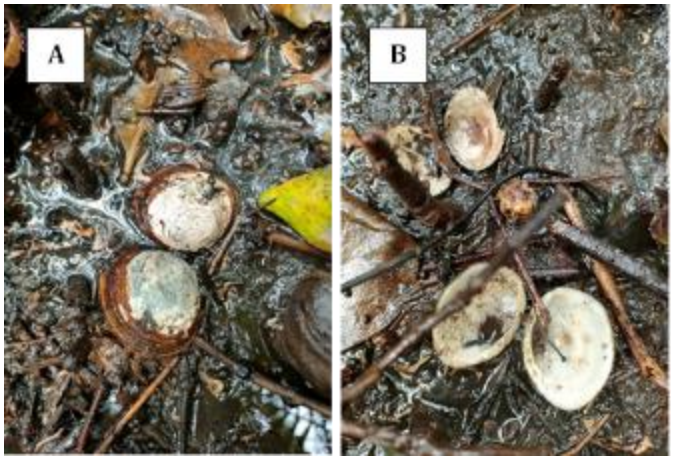


**Figure 1** External (A) and internal (B) shell structure of Bia Pece, Luwao, or Luawo

*Bia Paku*. This mollusk belongs to the group Gastropod and has a conical shape and a serrated shell. This type of mollusk is the most abundant or dominant in the mangrove forest in the Panango area. Usually, the fishermen can collect an average of 1 bucket weighing about 3 kg in one collection. The meat of the mollusks is collected by breaking the shell.


**Figure 2** Mollusk Form of Bia Paku (A) and Its Shell Fragments (B)

*Lango-Lango*. This mollusk is a type of Gastropod characterized by a 6-fingered shell. This mollusk walks on the surface of the substrate and does not dive into the mud. The number of individuals found is not as many as other mollusks that live in mangroves. This type of mollusk is only used for consumption by the fishermen themselves and is not traded. Its unique shell shape is often used by the fishermen to decorate their houses.

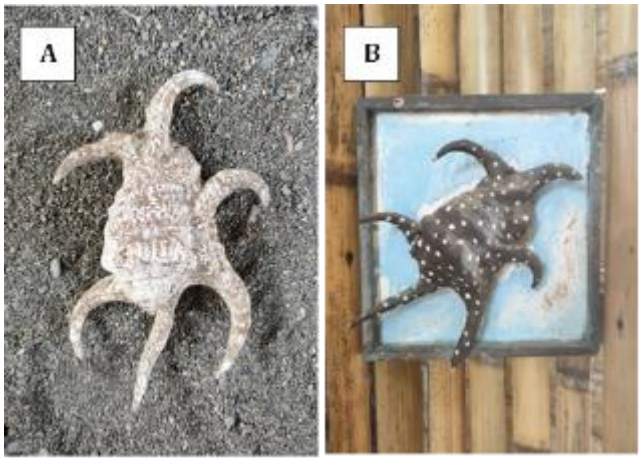


**Figure 3** Lango-Lango Shell Shape (A) and Lango-Lango Shell House Decoration (B)

*Pice* or *Pite*. This mollusk is a type of bivalve mollusk found on muddy substrates. It immerses itself in the mud, making it difficult to catch. Some fishermen use the boiled water of this mollusk as a medicine against typhoid.

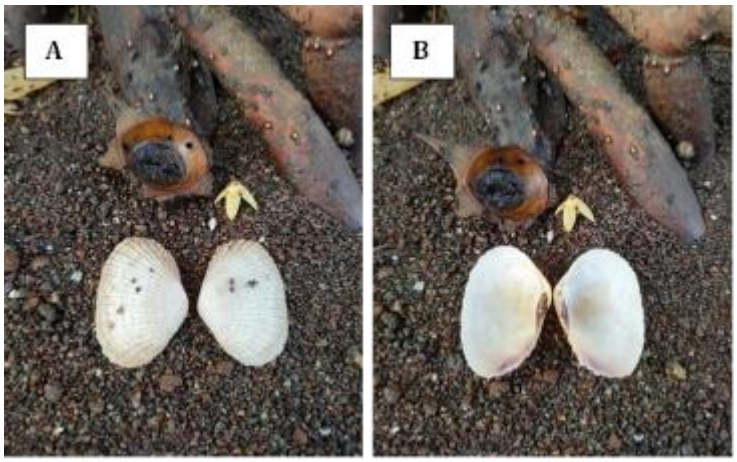


**Figure 4** Closed Pice or Pite Shell Shape (A) and Open Shell Shape (B)

The fishermen carry out this mollusk-collecting activity during the lowest tide of each month. Before consumption, the mollusk catch is left in a container filled with salt water for 1 night and can then be processed into food. At certain times, such as the beginning of the month of Ramadan, some fishermen often sell processed food from these mollusks in plastic boxes.

The results of mollusk collection can be counted, although they are not routinely traded and tend to be consumed only by the collecting fishermen. Fishers can collect an average of 3 kg in one search or each month. Based on the interviews, it is known that the results of collecting 1 kg of mollusks can be processed into food, divided into 5 plastic packaging boxes, or an average of 15 boxes/month. The selling price of each box is Rp. 5,000, so it is known that the average income of each fisherman is Rp. 75,000/month or Rp. 900,000/year. Expenses or operating costs incurred by the fishermen in each collection average Rp. 25,000/month or Rp. 300,000/year. The average total net income from collecting and selling mollusks is Rp. 600,000/year. If the number of collecting fishermen is about 20% of the total fishermen in Tabilaa village (41 people), Linawan (70 people), or only about 22 people. The 20% percentage of collecting fishermen was obtained from interviews with fishermen. The results of calculating the direct benefit value of mollusk production each year is Rp. 13,200,000/year.

### 3.5. Medicine

The use of materials from mangrove forests in the Panango area to produce traditional medicines for sale was not found. This can be understood due to the community's lack of knowledge regarding the processing of traditional medicinal ingredients from mangrove forests. Most parts of mangrove plants are useful as medicinal materials. Coastal

communities have widely used extracts and raw materials from mangroves for natural medicinal purposes. A mixture of natural chemical compounds by chemists is known as pharmacopeia. A number of mangrove plants and associated plants are also used as traditional insecticides and pesticides (Purnobasuki, 2004). At the time of observation, no people were using materials from the mangrove forest in the Panango area as medicinal ingredients.

Based on the results of the analysis of the direct benefits of provisioning services that the community receives from the potential of the mangrove forest in the Panango area, the value of each potential can be known. The results of calculating the value of the benefits of nipah leaves, fish, mollusks, and medicinal materials are shown in Table 1.

**Table 1** Results of Calculating the Direct Use Value of Provisioning Services in the Panango Area

| No. | Provisioning Services | Production | Price (Rp) | Operational (Rp) | Beneficiary | Beneficial Value (Rp/Year) |
|---|---|---|---|---|---|---|
| 1 | Nipah | 2,400 sheets | 4,000 | - | 2 Fishermen | 9,600,000 |
| 2 | Bagan of 9-month season | 22,500 Kg | 6,000 | 90,000,000 | 25 Unit | 45,000,000 |
| 3 | Bagan of 3-month season | 93,750 Kg | 6,000 | 90,000,000 | 25 Unit | 472,500,000 |
| 4 | Fishing in the 9-month season | 1,800 Kg | 40,000 | - | 25 Unit | 72,000,000 |
| 5 | Fishing in 3-month season | 1,800 Kg | 40,000 | - | 25 Unit | 72,000,000 |
| 6 | Mollusca | 3,960 Boxes | 5,000 | 6,600,000 | 22 Fishermen | 13,200,000 |
| Total Beneficial Value of Provisioning Services | | | | | | 684,300,000 |

Provisioning services are products derived from ecosystems such as food, raw materials, medicinal sources, energy, and resources contained therein (MEA, 2005). Direct benefits are the types of benefits that can be obtained directly from mangrove forests or as a form of actual benefits carried out by the community, such as taking wood, catching fish, catching crabs, catching shrimp, collecting shells, recreational tourism, and others (Samsul, 2013 in Kota et al., 2022). The results of this study are still relatively low compared to the value of fish utilization by fishermen in the mangrove forest of Lansa village, Wori subdistrict, North Minahasa Regency, which was reported to be Rp.1,521,429,000/year (Takarendehang, et al., 2018).

### 3.6. Potential and Beneficial Value of Regulating Services

**Table 2** Results of Calculating the Direct Use Value of Regulating Services in the Panango Area

| No. | Regulating Services | Price of Wall (Rp) | Amount of Breakwater (Volume) | Direct Beneficial Value |
|---|---|---|---|---|
| 1 | Construction of wave retaining wall | 1,700,000 | 5,709 | Rp. 9,705,300,000 |
| Total Value of Regulating Services | | | | Rp. 9,705,300,000 |

The results of the analysis based on the questionnaire showed that 80% of the respondents strongly agreed that the Panango area functions as a buffer against large waves, which is a regulatory service function of the mangrove ecosystem. The results of Anggraini et al. (2017) research on regulatory services in Rembang Regency stated that coastal erosion can cause the collapse of fishermen's pond embankments, which affects the economic activities of the community. The replacement cost method assumes that the amount of money spent by the community to replace environmental assets (services) is generally equal to the benefits lost from mangrove ecosystem services available to

the community as a sea wall (Van Beukering et al., 2007 in Idrus et al., 2016). The results of the calculation of the value of the environmental services of the mangrove forest Panango area as a breakwater can be seen in Table 2.

The data on the cost of breakwater construction is the result of the analysis of the Public Works and Spatial Planning Office (PUPR) of South Bolaang Mongondow Regency. The unit price of goods used is based on the unit price in 2022 for one breakwater unit, which is Rp. 1,700,000 with a size of 0.75 meters wide and 1.20 meters long. Based on the measurement method carried out by GIS (Geographic Information System), it is known that the length of the coastline of the Panango area mangrove forest is 6,851 meters. This means that with this length of coastline, the Panango mangrove ecosystem needs 5,709 breakwaters. Thus, the value of indirect benefits from regulating services provided by mangroves as breakwaters can be estimated as Rp. 9,705,300,000 with a useful life of about 10 years. This result is relatively higher than that reported by Takarendehang, et al. (2018) that the value of benefits from mangrove forests as wave barriers in Lansa Village, Wori District, North Minahasa Regency was Rp. 2,583,300,000.

### 3.7. Potential and Beneficial Value of Cultural Services

The valuation of the cultural services of the mangrove forest in the Panango area is seen from the existence value of the area. The existence value, also called the existence benefit value, is the value measured by the benefits that the community derives from the existence of mangrove ecosystems. The results of the calculation of the value of cultural services of mangrove forests can be seen in Table 3.

**Table 3** Results of Calculating the Direct Use Value of Cultural Services in the Panango Area

| No. | Cultural Services | Cultural Values (Rp/Ha) | Total Area (Ha) | Direct Beneficial Value |
|---|---|---|---|---|
| 1 | Area existence value | 150,000,000 | 105.64 | Rp. 15,846,000,000 |
| Total Value of Cultural Services | | | | Rp. 15,846,000,000 |

Table 3 shows that the direct benefit value of cultural services from mangrove ecosystem in the Panango area has a total value of Rp. 15,846,000,000, - which shows the value of existence or existence of the Panango area. This value is obtained from the average rupiah value (average/m2/year) given by respondents to value the existence of mangroves so that they are not extinct and sustainable. The average rupiah value obtained from the respondents is Rp. 15,000/m2/year or converted to Rp. 150,000,000/ha. The area of the Panango mangrove forest is 105.64 ha, so the value of its existence or existence is Rp. 15,846,000,000/year.

The value of existence or existence is a value that shows a person's willingness to value the existence of mangrove ecosystems in order to preserve mangrove ecosystems so that they do not become extinct for future use (Nanlohy, et al., 2021). The value of existence is the value of a person's concern for the existence of a resource in the form of value given by the community to the forest area for spiritual, aesthetic, and cultural benefits (Nurfitriani, 2006 in Bishop, 1999).

The amount of the value of the benefits of the existence of an area will vary depending on the size of the area, the willingness to pay, and the price valuation given by the community. As Nanlohy et al. (2021) reported the value of the existence of the Klawalu mangrove area in Sorong City with an area of 24.5 hectares amounted to Rp. 12,568,160.00 ha/year obtained from the average rupiah value given by respondents to value the existence of mangroves in the area, which is Rp. 34,200.00 m2/year. Nanlohy et al. (2021) stated that the difference in the value of existence benefits depends on the willingness to pay by the community, where the greater the willingness to pay, the greater their awareness and concern for the conservation of mangrove ecosystems and also due to the number of respondents and the extent of mangrove areas.

### 3.8. Potential and Beneficial Value of Supporting Services

The assessment of biodiversity in the Panango area was carried out using a research approach similar to that of Ruitenbeek (1992) on the biodiversity value of mangrove forests in Bintuni Bay, Irian Jaya. The results of the study indicated that the biodiversity value of mangrove forests in Indonesia is US $ 15/ha/year.

If the exchange rate of the dollar against the rupiah is Rp. 15,007 on July 31, 2023, the value of the benefits obtained is Rp. 225,105/ha/year. With an area of 105.64 hectares of Panango mangrove forest, the value of the benefits of mangrove forest biodiversity is Rp. 23,780,092.2 per year. The results of calculating the biodiversity value of the Panango area are shown in Table 5.

**Table 4** Results of Calculating the Direct Use Value of Supporting Services in the Panango Area

| No. | Supporting Services | Diversity Value (Rp) | Total Area (Ha) | Direct Beneficial Value |
|---|---|---|---|---|
| 1 | Biodiversity value | 15,007 | 105.64 | Rp. 23,780,092 |
| Total Value of Supporting Services | | | | Rp. 23,780,092 |

According to Anggraini, et al. (2017), who conducted a similar study on the calculation of ecosystem services using the calculation of biodiversity based on Ruitenbeek (1992), which is US $ 15 ha/year, found that the economic value in the three villages that became the site of his research gave different results proportional to the existing mangrove forest area. This proves that the more extensive a mangrove ecosystem, the greater the economic value of its biodiversity.

Based on the results of the study, the general potential and the results of the calculation of the total value of direct benefits from the mangrove ecosystem of the Panango area are shown in Table 5.

**Table 5** Potential and Direct Beneficial Value in the Panango Area

| No. | Potential | Direct Beneficial Value (Rp) |
|---|---|---|
| 1 | Provisioning Services | 684,300,000 |
| 2 | Regulating Services | 9,750,300,000 |
| 3 | Cultural Services | 15,846,000,000 |
| 4 | Supporting Services | 23,780,092 |
| Total | | 26,304,380,092 |

Table 5 shows that the total direct benefits of the potential services of mangrove forests in the Panango area amounted to Rp. 26,304,380,092/year. The potential with the highest benefit value is cultural services with a value of Rp. 15,846,000,000/year and the lowest is the value of supporting services with Rp. 23,780,092/year. These results show that the community has realized the benefits of the existence of the Panango area mangrove ecosystem as shown by the results of their assessment.

### *3.9.* Strategy for Managing Ecosystem Services

Sustainability strategies for mangrove ecosystem services include a set of measures and actions aimed at the protection, management, and sustainable use of mangrove ecosystems. The results of the identification of internal and external factors were used in the SWOT analysis process. Internal factors are strengths and weaknesses, while external factors are opportunities and threats.

#### *3.9.1. Internal factors*

These internal factors influence the formation of Strengths and Weaknesses (symbolized by S and W). These two factors concern the conditions in the company or organization that influence the decision-making of the company or organization (Kurniasih, et al., 2021).

**Table 6** Weight, Rating, and Variable Score of the Internal Strategic Factor Questionnaire

| **Internal Strategic Factors Analysis Summary (IFAS)** | | | | |
|---|---|---|---|---|
| Strength (S) | | Weight | Rating | Score |
| 1 | The Panango area has a large area of mangrove forest that is beneficial to the community | 0.11 | 4.13 | 0.45 |
| 2 | The Panango area's mangrove forest serves as a source of food, including fish, timber, and medicine | 0.10 | 3.83 | 0.38 |
| 3 | Panango Area Mangrove Forest functions as a sea wave barrier | 0.11 | 4.33 | 0.47 |

| | | | | |
|---|---|---|---|---|
| 4 | The mangrove forest in the Panango area can be developed as an eco-tourism area | 0.10 | 3.97 | 0.41 |
| 5 | Mangrove forest in the Panango area has biodiversity | 0.10 | 4.10 | 0.42 |
| Weakness (W) | | | | |
| 1 | Limited data and information on Mangrove ecosystem services in the Panango Area | 0.10 | 3.80 | 0.36 |
| 2 | Limited use of technology to harness the results of mangrove ecosystem services in the Panango area | 0.09 | 3.67 | 0.33 |
| 3 | Lack of socialization about the management of the Panango Area Mangrove Ecosystem | 0.10 | 4.00 | 0.40 |
| 4 | Limited resources for mangrove forest management in the Panango area | 0.09 | 3.87 | 0.36 |
| 5 | Lack of public understanding of the function of the Panango Area Mangrove Forest | 0.10 | 4.00 | 0.39 |
| Total | | | | 3.98 |

Table 6 shows that the Internal Strategic Factors Analysis Summary (IFAS) has a total score of 3.98. The highest weight value in the strength factor is found in the criteria "The Panango area has a large area of mangrove forest that is beneficial to the community", "The Panango area's mangrove forest serves as a source of food, including fish, timber, and medicine", and "Panango Area Mangrove Forest functions as a sea wave barrier" with a weight of 0.11 each. The highest weights on the weakness factor are found in the criteria "Limited data and information on Mangrove ecosystem services in the Panango Area", "Lack of socialization about the management of the Panango Area Mangrove Ecosystem", and "Lack of public understanding of the function of the Panango Area Mangrove Forest" with a weight of 0.10 each. Based on these results, the strength factors can be effectively utilized to minimize the weakness factors in the Panango Area.

*3.9.2. External factors*

**Table 7** Weight, Rating, and Variable Score of the External Strategic Factor Questionnaire

| **External Strategic Factors Analysis Summary (EFAS)** | | | | |
|---|---|---|---|---|
| Opportunity (O) | | Weight | Rating | Score |
| 1 | Has the potential as a source of food, such as fish, wood, and medicine that can be developed | 0,11 | 3,80 | 0,41 |
| 2 | Acts as a sea wave barrier in the Panengo area | 0,11 | 4,17 | 0,45 |
| 3 | Has potential for ecotourism development | 0,11 | 3,83 | 0,42 |
| 4 | Has the potential to develop technology for the utilization of mangrove forest products | 0,10 | 3,20 | 0,31 |
| 5 | Has the potential as a location for research and innovation | 0,10 | 3,70 | 0,38 |
| Threat (T) | | | | |
| 1 | Over-exploitation of fish, timber, and other materials in the Panango mangrove forest area. | 0,09 | 3,57 | 0,31 |
| 2 | Lack of public knowledge about the function of mangrove ecosystems | 0,10 | 3,90 | 0,39 |
| 3 | Environmental pollution in the Panango area due to activities of the community | 0,10 | 3,97 | 0,40 |
| 4 | The shift in land use may have an impact on the sustainability of the mangrove ecosystem in the Panango area | 0,09 | 3,70 | 0,33 |
| 5 | Lack of public attention to the sustainability of ecosystem areas | 0,10 | 3,63 | 0,36 |
| Total | | | | 3,76 |

These external factors affect the formation of Opportunities and Threats (abbreviated as O and T). These factors concern conditions outside the company or organization that affect the decision-making of the company or organization. This

factor includes the industrial and macro business environment, economy, politics, law, technology, population, and social resources (Kurniasih, et al., 2021).

Table 7 shows that the External Strategic Factors Analysis Summary (EFAS) has a total score of 3.76. The highest weighted value in the opportunity factor lies in the indicators "Has the potential as a source of food, such as fish, wood, and medicine that can be developed", "Acts as a sea wave barrier in the Panengo area" and "Has potential for ecotourism development" with a weight value of 0.11. For the threat factor, the indicator "Lack of public knowledge about the function of mangrove ecosystems", "Environmental pollution in the Panango area due to community activities", and "Lack of public attention to the sustainability of ecosystem areas" have the highest weight value of 0.10.

According to Salim (2019), the results of these calculations aim to determine the position of the ordinate point in the SWOT quadrant graph. The results of scoring for each of these factors are analyzed by placing these factors in quadrants based on a combination of internal factors (Strengths and Weaknesses) with external factors (Opportunities and Threats) on the Panango Area mangrove forest variable, with reference to Rangkuti (2021). The quadrants are as follows:

Quadrant I: Aggressive Strategy (Strengths-Opportunities), where the focus is on using internal strengths to maximize external opportunities. Here, strengths are used to take advantage of existing opportunities. This state is a very favorable situation. The strategy has opportunities and strengths to take advantage of existing opportunities. The strategy to be applied in this state is to support an aggressive growth policy (Growth-Oriented Strategy).

Quadrant II: Diversification Strategy (Strengths-Threats), focuses on maximizing internal strengths to overcome external threats, i.e., using strengths to reduce the negative impact of threats. Despite facing various threats, this strategy still has internal strengths. The strategy to be implemented is to use strengths to take advantage of long-term opportunities through a diversification strategy (products/services).

Quadrant III: Change Strategy (Weaknesses-Opportunities), focuses on overcoming internal weaknesses to take advantage of external opportunities. Existing weaknesses are improved by taking advantage of opportunities. The focus of this strategy is to minimize internal problems in order to take advantage of better opportunities.

Quadrant IV: Survival Strategy (Weaknesses-Threats), focuses on reducing internal weaknesses and avoiding or overcoming external threats. Improve weaknesses and deal with threats to survive in a difficult environment. This condition is a very unfavorable situation because the strategy faces various threats and internal weaknesses.

The results of calculating the score value of the external conditions as shown in Table 7 show a total value of 3.98, which is obtained from the total score value of the strength factor of 2.13 and the score value of the weakness factor of 1.84. Meanwhile, the external factors have a total score value of 3.76, which is obtained from the opportunity factor score value of 1.97 and the threat factor score value of 1.97. The SWOT analysis diagram is shown in Figure 5.

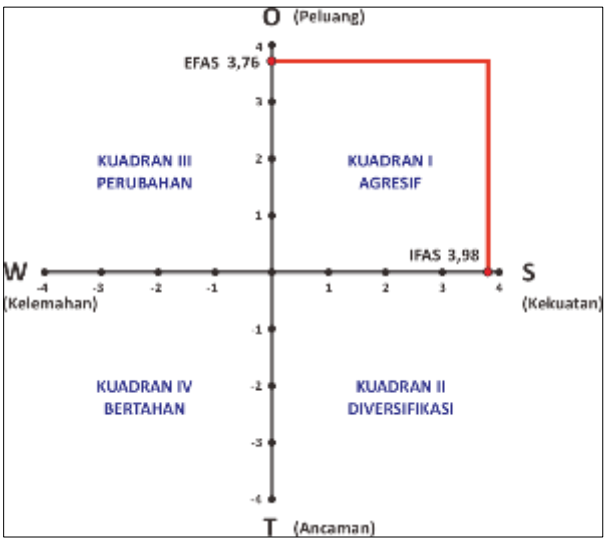


**Figure 5** Graph of Questionnaire Calculation Results and Placement of Points in the SWOT Analysis Quadrant

Based on the SWOT analysis, it is known that the results of the analysis through questionnaires show that the strategy that needs to be done is the aggressive strategy (Strengths and Opportunities), which is a strategy that uses strengths to take advantage of opportunities as in quadrant I (as an aggressive quadrant). Strategies and directions for mangrove forest ecosystem management in the Panango area are at IFAS point 3.98 and EFAS point 3.76. This is a very good situation where the use of mangrove ecosystems as an ecosystem service area has great strengths to make the best use of opportunities.

### *3.10.* Define Ecosystem Management Strategies for the Area

The SWOT matrix is used to compile strategic factors that can be used for the management of the Panango Area ecosystem. Yaqin (2021) states that the SWOT matrix is a tool used to compile strategic factors of the company. At this stage, it is clearly described how the internal strengths and weaknesses are owned to adjust opportunities and threats. The SWOT matrix is shown in Table 8.

Based on the results of the analysis listed in Table 9, a very important strategy that can be used for the development and sustainable management of the Panango Area is the aggressive strategy (Strengths and Opportunities) as shown in Figure 7. From the results of the strategic analysis, as in the SWOT matrix, several strategies can be adopted. However, from these various alternatives, there are five alternatives obtained by aligning the SWOT matrix and the SWOT diagram, namely the S-O strategy.

**Table 8** Mangrove Forest Management Strategy for Panango Area through SWOT Analysis

| | | Opportunity (O) | Threat (T) |
|---|---|---|---|
| | | Has the potential as a source of food, such as fish, wood, and medicine that can be developed<br>Acts as a sea wave barrier in the Panengo area<br>Has potential for ecotourism development<br>Has the potential to develop technology for the utilization of mangrove forest products<br>Has the potential as a location for research and innovation | Over-exploitation of fish, timber, and other materials in the Panango mangrove forest area.<br>Lack of public knowledge about the function of mangrove ecosystems<br>Environmental pollution in the Panango area due to activities of the community<br>The shift in land use may have an impact on the sustainability of the mangrove ecosystem in the Panango area<br>Lack of community attention to the sustainability of ecosystem areas |
| Strength (S) | The Panango area has a large area of mangrove forest that is beneficial to the community<br>The Panango area's mangrove forest serves as a source of food, including fish, timber, and medicine<br>Panango Area Mangrove Forest functions as a sea wave barrier<br>The mangrove forest in the Panango area can be developed as an eco-tourism area<br>Mangrove forest in the Panango area has biodiversity | Make attempts to conserve and protect the area<br>Sustainable management involving communities, local and non-local governments<br>Community empowerment through training and active participation<br>Identify economic opportunities for the region<br>Conduct research and innovation in the area | Leveraging local community engagement to address threats<br>Harnessing the biodiversity of the mangrove ecosystem<br>Educate the public about the benefits of mangrove ecosystems |

| | | | |
|---|---|---|---|
| Weakness (W) | Limited data and information on Mangrove ecosystem services in the Panango Area<br>Limited use of technology to harness the results of mangrove ecosystem services in the Panango area<br>Lack of socialization about the management of the Panango Area Mangrove Ecosystem<br>Limited resources for mangrove forest management in the Panango area<br>Lack of public understanding of the function of the Panango Area Mangrove Forest | Preserve existing acreage and restore land<br>Sustainable land use planning through government and community cooperation<br>Education and awareness programs to reduce waste | Partnership and cooperation through partnerships with other organizations or institutions<br>Identifying and strengthening ecosystem services where there is a benefit |

The results of the analysis in this study that can be implemented or used as an alternative management strategy for the Panango area are using the aggressive strategy (Strengths and Opportunities).

Alternative 1: Conservation and protection of the area. This activity can be carried out through conservation efforts by zoning the Panango mangrove forest and making regulations by the local government in an effort to protect the area.

Alternative 2: Sustainable management involving the community, local government, and non-local government. Sustainable management through the development of a mangrove ecosystem management plan that involves the participation of the communities surrounding the area, the local government, and non-governmental organizations.

Alternative 3: Community empowerment through training and active participation. Community empowerment in mangrove ecosystem conservation through training, education, and active participation programs.

Alternative 4: Identifying regional economic opportunities. Sustainable economic development through the identification and development of economic opportunities such as nature tourism development, mangrove cultivation, and processing of mangrove ecosystem products.

Alternative 5: Undertake regional research and innovation. Research and innovation by supporting scientific research on mangrove ecosystems, including a deeper understanding of the ecology, species found in the Panango area, and the impact of climate change on the ecosystem.

Management of mangrove ecosystem services is essential to maintain environmental balance and support livelihoods. Determining this strategy can help sustainably manage mangrove ecosystem services, maintain biodiversity, and support the welfare of communities in the Panango area that depend on this ecosystem. The results of the research conducted by Utomo, et al. (2017) mentioned that the main forces in mangrove area management that affect the community's economy are government agencies and community organizations, so the strategy can be done is to involve the community to participate in sustainable mangrove forest management. Nijikuluw (2002) states that involving local communities in management can have positive benefits, namely, it can promote equity in the management of fishery resources, it can reflect the specific needs of local communities, it can be responsive and adaptable to variations in local social and environmental conditions, and local communities are motivated to manage resources sustainably.

## 4. Conclusion

The conclusions drawn from the research on the ecosystem services of the mangrove forest in the Panango area are as follows:

The potential ecosystem services identified in the area are four services consisting of provisioning services, which include *nipah* as a roofing material, fish through fishing gear and rods, mollusks as food and traditional medicine;

regulating services as a breakwater function; cultural services, namely the existence or existence of ecosystems; and supporting services, namely biodiversity.

The total value of ecosystem service benefits in the area amounted to Rp. 26,259,380,092/year, consisting of consecutive benefit values of provider services Rp. 684,300,000/year, regulating services Rp. 9,705,300,000/year, cultural services Rp. 15,846,000,000/year and supporting services Rp. 23,780,092/year.

Management strategies for the potential and value of mangrove ecosystem services in the Panango area can use 5 (five) alternative strategies, namely conservation and protection of the area; sustainable management by involving the community, local government, and non-local government; community empowerment through training and active participation; identification of regional economic opportunities; and conducting regional research and innovation.

## Compliance with ethical standards

*Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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