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# ECONOMIC VALUATION OF SEAWEED CULTIVATION IN MANGROVE ECOSYSTEM WATERS NUNUKAN DISTRICT: THE OUTER ISLANDS OF THE INDONESIA-MALAYSIA BORDER

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**ABSTRACT**

The research objective was to analyze the direct benefits of the mangrove ecosystem as a provider of seaweed aquaculture and to analyze whether the mangrove ecosystem management patterns carried out by farmers were optimal. The research was conducted at two locations, namely in the waters of the mangrove ecosystem, Tanjung Harapan, and the waters of the Mansapa mangrove ecosystem, Nunukan District, the outer island of the Indonesia-Malaysia border. Type of survey research. The research sample is seaweed cultivators. The analysis method used is Market Value analysis and Benefit-Cost Analysis. The results of the study (1) the direct benefit value of the Tanjung Harapan mangrove ecosystem is IDR 10,481,586,441 per ha per year (IDR 873,465,536 per ha per month) and Mansapa is IDR 1,850,995,241 per ha per year (IDR 155,249,603 per ha per month). The overall benefits of the mangrove ecosystem in the two locations amounted to IDR. 122,715,139 per ha per month. Tanjung Harapan contributed 85% and Mansapa contributed 15%. (2) the management pattern carried out by the seaweed cultivator community in the mangrove ecosystem is not yet optimal. Management alternatives that provide optimal utilization value are increasing land use for seaweed cultivation and reducing activities outside of seaweed cultivation by 10%.

***Keywords***: Economic valuation, direct benefits, mangrove ecosystem, seaweed, *Kappaphycus alvarezii*

## Introduction

Indonesia is the largest archipelago in the world, which is very strategic, both economically and geopolitically. Archipelagic groups in Indonesia are united by a sea that stretches out (Lentera Bisnis, 2019; Kana Kurnia, 2020). Nunukan District, which is located in the northern region of North Kalimantan province, is one of several groups of islands. Nunukan is directly adjacent to the state of Malaysia, therefore Nunukan is included in the category of the outer island of the Indonesia-Malaysia border

Nunukan has enormous mangrove potential. The length of the coastline of Nunukan District is 547.70 km. of these, 91.70% (502.23 km) are mangrove ecosystems, and 75,283.20 ha have been utilized. (DKP of North Kalimantan Province, 2020). Mangrove forests are a green strip of coastal areas that have ecological and socio-economic functions (Muntalif, Hasian, and Sembiring, 2013). With such a large mangrove potential, the mangrove ecosystem area functions as a fishery provider, contributing directly to local communities with various professions in the fishery sector, among others; catch fishermen, pond cultivation, seaweed cultivation, and so on.

Seaweed cultivation in Nunukan district is growing very fast. Nunukan seaweed is one of Indonesia's mainstay seaweeds. The development of Nunukan seaweed cultivation is centered in the South Nunukan sub-district, precisely in the Tanjung Harapan and Mansapa villages. The type of seaweed that is being developed is the *Kappaphycus alvarezii* type or more popularly known as *Eucheuma cottoni*. *K. alvarezii* is a type of edible red seaweed, which is rich in nutrients and nutraceuticals. This type of seaweed is generally cultivated using the longline system or method (Parenrengi and Sulaeman, 2007; Soenardjo, 2011; Damayanti, Aryawati, and Fauziyah, 2019).

Longline seaweed can last all year round. Seaweed cultivation activity develops followed by the clearing of mangrove forest land. Therefore activities in the mangrove ecosystem area need priority attention given the condition of the mangrove forest which continues to experience shrinkage due to damage caused by natural factors as well as damage caused by human treatment.

According to Ghufran (2015), the main problem regarding the influence of pressure on mangrove habitat comes from the desire of humans to convert mangrove forests into commercial activities resulting in over-exploitation of mangrove forests. Nunukan Districtwith 75,283.20 ha of mangrove forest area was also identified to experience shrinkage. The results of investigations in 4 sub-districts in Nunukan district, namely in Nunukan (Tanjung Cantik) sub-district, South Nunukan sub-district (Tanjung Harapan and Mansapa), Sebatik sub-district (Sungai Pancang), and West Sebatik sub-district (Setabu village and Binalawa village), found land clearing activities. mangrove forest. The community carries out the following activities:

- Clearing land for aquaculture ponds;

1. Taking mangrove wood for firewood, building supports, and for drying the seaweed;
2. Land clearing for seaweed farming activity infrastructure.

Mangrove has so many benefits. Apart from ecological benefits, the existence of mangrove forests also provides economic benefits of no small value. The three activities of the people of Nunukan district in the mangrove ecosystem area, besides having an impact on the direct benefits of mangrove forests, they also have an impact on indirect benefits. M Natsir, Jamaluddin, and Hasmin (2014) classify resource benefits into 4 categories, namely; direct benefits in the ecosystem that have a market value, direct benefits in the ecosystem that have no market value, indirect benefits outside the ecosystem that have market value and indirect benefits outside the ecosystem that have no market value.

This study aims to analyze the economic value of the direct benefits of seaweed cultivation in the mangrove ecosystem which has market value and to analyze the management patterns of mangrove ecosystems carried out by the cultivator community, in the mangrove ecosystem area of Nunukan district, whether the management pattern is optimal, feasible from this aspect. economics and ecology. An analysis is carried out using three patterns of utilization and then compared to obtain the optimal management pattern

## Materials and Methods

The research was conducted in January - March 2020 in Nunukan District, North Kalimantan Province, at 2 locations, namely in Tanjung Harapan Village and in Mansapa Village. The two locations were chosen deliberately because they are the center of the seaweed management area in Nunukan district. Retrieval of data includes primary data and secondary data. Primary data consists of information on the use of mangrove ecosystems obtained through surveys/interviews and secondary data including data on the general conditions of research and fisheries locations obtained from previous research, from the Fisheries and Marine Affairs Office, and the Plantation and Forestry Service. Respondents were selected by purposive sampling method based on considerations as beneficiaries of the mangrove ecosystem. Data analysis to answer the first problem; The direct benefit value of the mangrove ecosystem as a provider of seaweed aquaculture is used Market Value analysis and to answer the second problem, optimization of mangrove ecosystem management carried out by cultivators, whether it is optimal, use Benefit-Cost Analysis.

## Results

### Value of Direct Benefits of Mangroves as a Provider of Seaweed Cultivation Fisheries

Seaweed aquaculture is a commodity in the mangrove ecosystem that has a market value, therefore the direct benefit value of mangroves as a provider of seaweed cultivation is calculated using the Market Value approach, namely the price that consumers are willing to pay in a transaction to obtain goods and services or value from seaweed cultivation that everyone is willing to pay (Fruteau *et al*., 2009; Priambodo and Najib, 2014; Treynor, 2015).Sub-district Tanjung Harapan and Sub-district Mansapa are coastal areas located in the mangrove ecosystem of Nunukan District, and have a large enough potential for aquaculture and have very good market prospects. Based on the results of surveys/ interviews conducted on cultivators. The types and investment values used are as follows.

**Table 1 :** Types and Investment Value of Seaweed Cultivation in the Waters of the Mangrove Ecosystem in Nunukan Regency, 2020.

| No | Type of Investment | Investment Value (IDR) | |
|---|---|---|---|
| | | Tanjung Harapan | Mansapa |
| 1 | Location | 56.000.000 | 48.000.000 |
| 2 | Wooden Stakes (bh) | 14.000.000 | 14.000.000 |
| 3 | Mineral bottle buoys | 2.625.000 | 2.625.000 |
| 4 | Seed rope No.2 (rolls = 200 m) | 9.625.000 | 9.625.000 |
| 5 | Rope Stretch No.4 (rolls =200 m) | 15.750.000 | 15.750.000 |
| 6 | Tie rope between stretch No. 6 (kg) | 525.000 | 525.000 |
| 7 | Boats (unit) | 20.000.000 | 17.500.000 |
| 8 | Machines (unit) | 5.000.000 | 7.000.000 |
| 9 | Drying floor 6 x 4 m (unit) | 7.000.000 | 7.000.000 |
| 10 | Work equipment (package) | 700.000 | 700.000 |
| | *Total Value* | 131.225.000 | 122.725.000 |

Table 1 shows that the investment used in the long line method of seaweed cultivation in Nunukan is not much different from the investment used in seaweed cultivation in general. The investment consists of a location, wooden stakes, buoys, seed ropes, stretch ropes, straps, boats, machines, and drying floors. Investment is capital that is invested in the form of assets to be used in the future (Wibowo, Fauzi, and Adrianto, 2011). Meanwhile, according to Adhawati and Mallawa (2019) investment is initial funds or initial capital to obtain benefits in the future. The investment value for Tanjung Harapan seaweed cultivation is IDR 131,225,000 and Mansapa is IDR 122,725,000, resulting in a total benefit value of IDR 233,209,119,600 per year or IDR 12,332,581,682 per ha. The full benefit value of seaweed cultivation is shown in table 2.

**Table 2 :** Benefit Value of Seaweed Cultivation in Mangrove Ecosystem Waters in Nunukan District, 2020.

| Description | Tj Harapan | Mansapa | Total |
|---|---|---|---|
| Production/ year (kg) | 29.760 | 28.800 | 58.560 |
| Price/ kg | 15.000 | 15.000 | 15.000 |
| Production Value/year (IDR) | 446.400.000 | 432.000.000 | 878.400.000 |
| Production cost/ year (IDR) | 281.227.667 | 279.816.000 | 561.043.667 |
| Income /year (IDR) | 165.172.333 | 152.184.000 | 317.356.333 |
| Income /month (IDR) | 13.764.361 | 12.682.000 | 26.446.361 |
| Potential cultivators (org) | 1.200 | 230 | 1430 |
| Mangrove Potential (ha) | 18.91 | 18.91 | 18.91 |
| Total benefit value/ year (IDR) | 198.206.799.600 | 35.002.320.000 | 233.209.119.600 |
| Benefit/ ha (IDR) | 10.481.586.441 | 1.850.995.241 | 12.332.581.682 |
| Benefit Value/ month/ ha (IDR) | 873.465.536 | 154.249.603 | 1.027.715.139 |
| Benefit Value/ ha (%) | 85% | 15% | 100% |

Table 2. Explains that Tanjung Harapan is a provider of seaweed aquaculture with a benefit value of Rp. 198,206,799,600 per year, and Mansapa of Rp. 35,002,320,000 per year. With the mangrove potential of 18.91 ha, the direct benefit value of the Tanjung Harapan mangrove ecosystem is IDR 10,481,586,441 per ha per year or IDR 873,465,536 per ha per month and Mansapa is IDR 1,850,995,241 per ha per year or IDR 154,249 .603 per ha per month. The overall benefits of the mangrove ecosystem at the two locations amounted to IDR 1,02,715,139 per month per ha, where Tanjung Harapan contributed 85% and Mansapa contributed 15%. Tanjung Harapan has a benefit value far greater than the value of the benefits of cultivating latut mansapa grass. The significant difference in the value of the benefits of seaweed cultivation between Tanjung Harapan and Mansapa is due more to the fact that the number of cultivator households in Tanjung Harapan is more than 1,200 cultivators, while the household of seaweed cultivators in Mansapa is only 230 cultivators.

**Optimization of Mangrove Ecosystem Management**

Sustainability is the most important point in mangrove ecosystem management. Management should be carried out in a balanced manner between economic benefits and ecological benefits so that the preservation of the mangrove ecosystem is maintained. (Fatma, 2016) Benefit-Cost Analysis is an analysis used to determine whether the management pattern of mangrove ecosystems carried out by cultivator communities in the mangrove ecosystem area of Nunukan district, especially the South Nunukan sub-district, is optimal, feasible from economic and ecological aspects. The analysis was carried out using three utilization patterns and then compared to obtain the optimal management pattern. The results of these calculations are as follows.

**Pattern One**

Pattern one is a management pattern currently implemented by the community. The analysis is calculated based on the existing values without conducting an intervention scenario. The results of the benefit-cost analysis show that by using a discount factor of 20% for five years, the net present value of the total benefits of the mangrove ecosystem is Rp. 833,286,379,430 /year.

**Pattern Two.**

Pattern two is a management pattern using the assumption of reducing land use for seaweed cultivation by 10% and increasing other fishery activities outside of seaweed cultivation by 10%. As a consequence of the reduced land use for seaweed cultivation, the production and production costs of seaweed are reduced by 10%. The activity and value of other fisheries outside seaweed cultivation increased by 10%. Another factor is considered constant (*centriparibus*). By using a discount factor of 20% calculated for five years, the present value of the total benefits of the mangrove ecosystem is IDR 778,068,972,850 per year. The value obtained is smaller than the present value of the total benefits of the mangrove ecosystem pattern one.

**Pattern Three.**

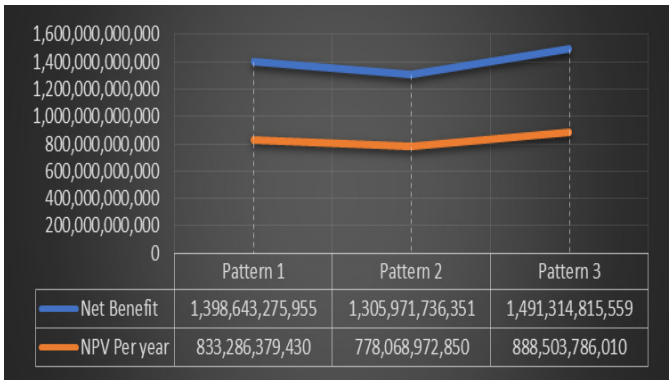
Pattern three is a management pattern using the assumption of increasing land use for seaweed cultivation by 10% and reducing other fishery activities outside seaweed cultivation by 10%. As a consequence of the additional land use for seaweed cultivation, the production and production costs of seaweed increased by 10%. On the other hand, fisheries outside cultivation have decreased by 10%. Another factor is considered constant (*centriparibus*). The results of the cost-benefit analysis calculation show that by using the discount factor of 20% for five years, the net present value of the total benefits of the mangrove ecosystem is Rp. 888,503,786,010 per year.

## Discussion

Seaweed cultivation has great prospects in the waters of the Tanjung Harapan and Mansapa mangrove ecosystems in the South Nunukan sub-district. Tanjung Harapan is one of the pilot areas for seaweed cultivation in Nunukan Regency. The type of seaweed developed by the cultivator community is the *Kappaphycus alvarezii* (*cottonii*) type. According to Chang, Okechukwu and Teo (2017), k.alvarezii is an important red tropical seaweed. This is in line with the opinion of Kreckhoff and Ngangi (2018) that K.alvarezii seaweed is one of the potential seaweed cultivation commodities with competitive market economic value. Seaweed cultivation in Nunukan district is growing very rapidly. According to Avianti, Hendiarti, and Handayani (2015) initially seaweed cultivation was only a side business when fishermen stopped fishing, but in its development,

seaweed cultivation has now become the main business so that there is a paradigm shift. Most of the coastal communities who initially worked as fishermen have turned into seaweed cultivators. The cultivation method developed is the longline method, namely the cultivation method using a long stretched rope. According to Basir, Abukena, and Amiluddin (2017) to produce high-quality seaweed it is important to consider cultivation methods based on the characteristics of coastal areas. In addition to this, the longline cultivation method is in demand by the community because the investment used is relatively cheap and easy to obtain. On average, each cultivator has 1-3 locations with a total stretch of 1,000 - 3,000 stretches. The length of the rope is about 25 m stretches. The distance between the ropes is 50 cm and the distance between the points of bonding for seaweed seeds is about 15 cm. one bonding point takes 50 gr. One stretch requires an average of 7.5 kg of seed. One stretch can produce dry harvest weights of around 13-15 kg. The seaweed cultivator activity takes place throughout the year without interruption. Harvesting is carried out at the age of 35 - 45 days (National Standardization Agency, 2010; WWF-Indonesia, 2014) Seaweed harvested by farmers is generally sold in dry form with a maximum moisture content of 30%. The selling price of dried seaweed (at the time of the research) was IDR 15,000 / kg. The cultivators sell their seaweed to collectors, then the collectors are sent to several exporters in Surabaya and Makassar. Export destination countries consist of Hong Kong, the Philippines, Malaysia, and several countries in Europe.

As an area located on the border, cultivation management complications often occur. In the focus group discussion (FGD) activity organized by the Directorate General of Capture Fisheries-Ministry of Marine Affairs and Fisheries, cultivators are asked to be more careful not to cross Malaysian waters. At sea, the boundary between Indonesia and Malaysia is invisible. If you cross the line, you are considered to have worked in Malaysia. To work in Malaysia, you must have official documents. In January 2019, several Nunukan seaweed cultivators were arrested by Malaysian officials for crossing Malaysian waters. After going through a process of transgressing the boundaries of Malaysian waters, dozens of these seaweed cultivators were finally returned to Nunukan (Darilaut.ID, 2019). Complex interests in trade also often occur between seaweed collectors and Malaysians. On the one hand, cross-border trading activities can increase economic growth every year. But on the other hand, rampant illegal activities and potential natural resources that have not been managed optimally and the availability of infrastructure are still insufficient, making the economic value of this sector not optimal. (Shafitri, Zulham, and Muawanah, 2020). This is in line with the research results obtained. On the one hand, the results of the research show that the economic value of seaweed aquaculture is very large, but on the other hand, the management pattern carried out by farmers is not optimal. By using 3 patterns, namely pattern 1 (real conditions), pattern 2 with the assumption of reducing cultivated land to increase other activities outside of seaweed cultivation, and pattern 3 with the assumption of increasing cultivated land and reducing fishery activities outside of seaweed cultivation, obtained Net Present Value ( NPV) or the net present benefit value (Lallemand *et al*., 2015) of the three patterns is as follows.




| | Pattern 1 | Pattern 2 | Pattern 3 |
|---|---|---|---|
| Net Benefit | 1,398,643,275,955 | 1,305,971,736,351 | 1,491,314,815,559 |
| NPV Per year | 833,286,379,430 | 778,068,972,850 | 888,503,786,010 |

**Fig. 1 :** Seaweed Cultivation Management Pattern

In Figure 1, it can be seen that pattern three is the management of mangrove ecosystem resources which has the greatest benefit value of the other two patterns. In pattern two, reducing land use for seaweed cultivation and increasing other fishery activities outside seaweed cultivation by 10% each, causes the value of management benefits to be not optimal. The value of benefits received is below or smaller than pattern one and pattern three. Conversely, increasing land use for seaweed cultivation and reducing other activities (centriparibu) respectively by 10%, causes the benefit value to increase. The value of benefits received is above the value of pattern one and pattern two. Thus, the management pattern of direct mangrove forest utilization by the community in Nunukan district is not optimal. The management alternative that provides optimal utilization value is pattern three. Resource management is said to be optimal if it can provide greater benefits to society. optimization concerns the use of resources wisely for the preservation of natural resources for mankind in the future.

## Conclusion

The direct benefit of the Tanjung Harapan mangrove ecosystem as a provider of seaweed aquaculture is relatively large, amounting to IDR 10,481,586,441 per hectare per year and Mansapa IDR 1,850,995,241 per ha per year. However, the management pattern carried out by the seaweed cultivator community in the mangrove ecosystem is not yet optimal. Management alternatives that provide optimal utilization value are increasing land use for seaweed cultivation and reducing activities outside of seaweed cultivation by 10% each.

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