Seaweed farming and seaweed capture fishermen phenomenon in Sebatik Strait, Nunukan Regency

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Abstract. Nunukan Regency - North Kalimantan, is currently one of the biggest producers of Kappaphycus alvarezii in Indonesia. The large number of seaweed farmers showed that the seaweed business economically increases the Nunukan and surrounding community’s income. An interesting phenomenon in the Nunukan Regency is the fishermen who capturing seaweed drifted due to sea currents. Conflicts of sea area utilization are still an issue in Sebatik Strait. This paper aims to analyze the prevalence of conflicts arising from space competition between seaweed catcher and seaweed farmer. This study was conducted using existing field data and reviewing secondary data using descriptive and quantitative approach. The field data was obtained by in-depth interviews and distributed questionnaires to seaweed farmers and seaweed stakeholders in Nunukan region. The recommendations for seaweed business development strategies are divided into three strategies: short-term, mid-term, and long-term strategies in the Sebatik Strait, presented at the end of this paper.

1. Introduction
The Sebatik Strait is located in Nunukan Regency, North Kalimantan Province, which is directly adjacent to the State of Sabah, East Malaysia. Nunukan can be said as the northern terrace of Indonesia. Nunukan Regency is very advanced in the business of cultivating Kappaphycus alvarezii (cottonii of the trade) seaweed with the longline method and planting time for 45-50 days in accordance with the Decree of the Minister of Marine Affairs and Fisheries Number 1 of 2019 [1]. This is evidenced by the peak of seaweed production in Nunukan occurred in 2015. It reached 26,130.2 dry tons and the number of seaweed business households reached 2,690 according to the data from the Local Fisheries Service at Nunukan Regency (2018) (Figure 1). This seaweed production is sold for the domestic market and exported to China through distribution in Makassar and Surabaya and has also been successfully exported directly to Busan, South Korea based on seaweed demand (In-person interview, Nunukan Fisheries Office, 2018).

This seaweed business helps coastal households starting from obtaining seeds, tightening them on the ropes and marketing the dried seaweed. In the seaweed growing season, in a day, seaweed tightening workers can earn up to Rp. 150,000.00 with a wage of Rp. 8,000 - Rp. 10,000 per rope. Seaweed seeds are tied using a rope approximately 25 m long and about 100 seedling bundles per rope [2]. One worker per day can get 15 ropes (1,000 to 1,500 ties). Prior to harvest time, the farm owners usually maintain and clean the seaweed farming on regular basis such as every other day. At harvest time, labour is needed to dry seaweed. These workers are paid Rp. 5,000 per kilogram of dried seaweed. Each worker can dry
about 1-2 tons of seaweed in 3-4 days. Thus, the wages that can be received are between Rp. 500,000 - Rp. 1,000,000.00 per one drying period [3].

Seaweed Farmers Households (SFH or RTP=Rumah Tangga Perikanan) from 2012 to2018 can be seen in Figure 1, there was a decline in 2016 and 2017, but increased again in 2018. The decline occurred due to several seaweed cultivation businesses in the border areas of North Kalimantan and East Malaysia closed or stopped the operation (personal communication with several sources, seaweed farmers and DKP Nunukan Regency)[4]. Conflicts in the areas of fishermen and seaweed farmers are also one of the reasons for the decline in the number of businesses in the seaweed sector. Seaweed cultivation in the Sebatik Strait, Nunukan Regency is also found in the shipping crossing zone. There are at least 13 locations for seaweed cultivation in the shipping zone that need to be removed, namely around the waters of Kinabasan Island, Muara Sei Ular waters, Tanjung Batu waters, Sei Banjar waters, Tanjung Cantik waters, Tanjung Harapan waters, Muara Nunukan, and Tanjung Bilas waters. In that area, when there are ships passing through the seaweed cultivation area, a lot of seaweed will be released from the ropes, in addition to the main factor being strong currents and tidal wave[5]. However, this has a positive impact on seaweed catching fishermen or seaweed trawlers as the more seaweed is released from the rope, the more seaweed can be caught and collected and this affects their income.

Figure 1. Number of Seaweed Farmer Household during 2012-2018 in Nunukan [5]

In Nunukan Regency, ownership of seaweed business assets continues to grow. The land area ownership has doubled from 1,287.38 hectares (in 2012) and was recorded at 2,652.8 hectares in 2018 [4]. Each farmers on average has a seaweed rope range of 500-800 pieces. Although this seaweed cultivation business is very promising in alleviating poverty in Nunukan Regency, seaweed cultivation also has unique challenges in Nunukan Regency. Conflicts or disputes between seaweed farmers and fishermen who switch to catch seaweed that breaks or drifts from seaweed ponds can be a threat to seaweed cultivation. Resource conflict is defined as efforts to use resources for the benefit of several groups [6]. In this paper, the conflicts that occur between seaweed growers/farmers and seaweed catchers will be studied. The conflict in this paper belongs to Type III in the typology of conflict as described below between fellow users of marine and fishery resources.

According to Charles [7] and Warner [8], the types of conflict in fisheries resources include: a) Type I: Who controls access to the fishery; b)Type II: How to control the utilization of fisheries resources such as quotas, law enforcement, and others; c) Type III: Relationships with other users of the fisheries sector such as small-scale fisheries, large-scale fisheries, racial differences, fishing technology differences and others; d) Type IV: relationship between fishery and non-fishery users such as tourism, mining, marine industries and so on; and e) Type V: the relationship between the fisheries sector and other sectors such as politics, corruption and others.

This study will discuss and analyze on; 1) the welfare of seaweed farmers in Nunukan including asset ownership, income and household expenditures of seaweed farmers and 2) the prevalence of conflicts that arise from competition for space between seaweed catchers and seaweed farmers.
2. Methods
Based on field data originating from questionnaire sources, information from actors and secondary information in Nunukan District and South Nunukan District (Sebatik Strait Waters), this paper is processed using a descriptive and qualitative approach on socio-economic conditions of seaweed farmers and the prevalence of the conflicts among seaweed farmers and fishers [9-12]. Several recommendations for strategy for developing seaweed business in the Sebatik Strait are presented at the end of this paper.

3. Result and Discussion
Seaweed cultivation areas are located in the Sebatik Section and the coastal waters of South Nunukan, about 3-4 km from the shoreline [13]. The map of the study location is depicted in Figure 2. Field data collection was carried out in April 2018 in Nunukan and South Nunukan Districts. The method of data collection was done by filling out questionnaires and interviews with 79 respondents. The two sub-districts are centers of seaweed business in Nunukan Regency. The centre for seaweed cultivation is on the coast of South Nunukan Regency (Mamolo Village, Tanjung Harapan Village, Sei Lancang, and Sei Mengkudu); Nunukan District (Mansapa and Sedadap); West Sebatik Regency (Binalawan Village, Matingkas Village, Ujung Muara Barat Village, Setabu Village, Liang Bunyu Village, Tidung Village, and Bugis Village), and Sebatik Regency (Tanjung Karang). Seaweed fishing areas are located around the sea coast of these villages.

![Figure 2. Study locations in Nunukan District and South Nunukan District, Nunukan Regency for seaweed business actors in the Sebatik Strait (Source: DKP Kabupaten Nunukan [14]).](image-url)

3.1. Assets ownership of seaweed farming
The growth of seaweed production business facilities is also getting bigger to meet market demand. The expansion of ownership of seaweed cultivation assets encourages the growth of seaweed production business facilities, encourages spatial labor migration from South Sulawesi and Indonesian Workers from Tawau (Malaysia) to Nunukan, increases the number of temporary labor migrations from oil palm plantations to the seaweed business. Seaweed businesses in Nunukan and Sebatik require large numbers of workers for preparation, cultivation, harvesting and distribution.
The description above shows that the seaweed business is developing well in Nunukan Regency. The largest contribution to seaweed production in Nunukan came from Nunukan Island (97.98%). Meanwhile, Sebatik Island only contributes 2.02% of the total seaweed production in Nunukan Regency (DKP Nunukan Regency, 2018). According to the Nunukan DKP, the effort to capture seaweed using fishing gear and boats contributes up to 30% of the total seaweed production in Nunukan Regency. However, the seaweed farming business has encouraged the emergence of problems in the Sebatik Strait, such as spatial conflicts between seaweed farming and shipping lanes [15]. In addition, expansion of drying floors and housing units damaged mangrove forest areas in South Nunukan Regency and West Sebatik Regency and decreased water quality in the Sebatik Strait due to sedimentation and ocean currents dynamics.

Seaweed farmers in Nunukan District, Nunukan Regency, based on the type of assets owned in 2018, namely for food crops. Only 10.26% of seaweed farmers have their own food crop land, and that percentage has an average area of 0.52 ha for food crops with an average asset value of Rp. 16,000,000.00. Meanwhile, as many as 89.74% of seaweed farmers do not have land for food crops. Meanwhile, about 12.82% owned plantation land and the remaining 87.18% did not have plantation land, of the 12.82% the average land area was 3.28 ha with an average value of Rp. 208,330,000.00 [16].

3.2. Income of seaweed farmers in Nunukan District

For a long time, economic activity in Nunukan Regency has been dominated by Malaysia's economic life from currency, capital flows that reach half of the Nunukan Regency APBD, the availability of needed goods in the market [13]. Therefore, it is necessary to pay attention to the existence of economic activities that can prevent the flight of capital to Malaysia by the local government and the central government. Seaweed farming provides employment for local communities as well as for migrants.

Seaweed cultivation activities on Nunukan Island began in 2007, brought by immigrants from South Sulawesi, namely the Bone and Bugis ethnicities [5,17]. The population migrated to Nunukan Island in the hope of getting a better life than their original place [18]. Cultivating seaweed is one of the jobs that migrants have already done at their original place. According to respondent information, seaweed farming activities in their original cannot improve people's lives because of the increasingly limited land for seaweed cultivation and the increasing incidence of seaweed diseases, such as ice-ice. In the early days between 2007-2008, the pattern was applied, who, and what to do for the seaweed business in Nunukan [19]. This period can be regarded as a learning period for seaweed business actors and looking for appropriate patterns and opportunities for policy makers.

Seaweed cultivation activities are well developed on Nunukan Island because the sea and coastal areas are very suitable for seaweed growth. The development of seaweed farming activities can be seen from the number of farming households involved. Table 1 shows Seaweed Households in Nunukan District and South Nunukan District and explains that during 2012 to 2016 there was an increase in the number of farmers by 30%. For additional information, according to 2018 BPS data, the highest population distribution in Nunukan Regency is in the two sub-districts, respectively, Nunukan District and South Nunukan District, 35.79% and 13.31% of the total 201,580 inhabitants.

This increase in the number of seaweed households was triggered by several things, including: 1) the area that has the potential to be developed as a seaweed cultivation area is still very large, which is 29,811 ha [14]. While until 2015 the land that had been utilized by farmers was only 1,698 ha (about 5.6% of the total potential of cultivated land); 2) the price of dried seaweed is relatively increasing from year to year. In 2015, the average price of dried seaweed was Rp. 7,800.00 per kg then increased to Rp. 10,458.00 in 2017 and even in 2019 it reached Rp. 19,000 per kg dry; 3) the harvest of seaweed in the Nunukan area does not know the season, so that throughout the year seaweed cultivation continues.

The development of seaweed farming business activities can also be seen from the income received by farmers. Table 2 shows the distribution of income categories of seaweed farmers from two sub-districts, namely Nunukan District and South Nunukan District. The table shows that the income of seaweed farmers is around Rp. 3,000,000.00 per month. In Nunukan District, the largest income
distribution is in the category of income above IDR 9,000,000.00 per month. In South Nunukan Subdistrict, the largest income distribution is IDR 6-9 million per month. The amount of income of farmers is strongly influenced by the amount of production and the existence of alternative sources of income other than seaweed cultivation.

Table 1. Seaweed households in Nunukan Regency in 2012 - 2016

|          | 2012 | 2013 | 2014 | 2015 | 2016 |
|----------|------|------|------|------|------|
| Nunukan District | 512  | 452  | 454  | 548  | 592  |
| South Nunukan District | 802  | 1.031| 1.572| 1.633| 1.112|
| Total     | 1.314| 1.483| 2.026| 2.181| 1.704|

Table 2. The average income of seaweed farmers on Nunukan Island in 2018

| Source of Income             | Nunukan          | South Nunukan    |
|------------------------------|------------------|------------------|
|                              | Propotion of Respondents Answered (%) | Average Income (Rp) | Propotion of Respondents Answered (%) | Average Income (Rp) |
| Income from fishing business | 2.56 | 5,000,000 | - | - |
| Income from seaweed farming  | 100.00 | 12,299,333 | 100.00 | 6,842,500 |
| Income from other            | 2.56 | 7,000,000 | - | - |

Source: Primary data, 2018

The average monthly income in the last month for seaweed farmers on Nunukan Island in 2018 is a source of income from seaweed farmers from respondents who answered 2.56% which came from income from fishing businesses in Nunukan District, Nunukan Regency an average of Rp 5,000,000.00 per month or (37.97 %), and income from seaweed cultivation is Rp. 12,300,000.00/month or (93.39%), and income from other business income from 2.56% of respondents who answered an average of IDR 7,000,000.00/month. The total average income per month from the three sources of income is Rp. 13,170,000.00 per month. The lowest total income is Rp. 5,000,000.00/month, and the highest is Rp. 30,000,000.00 per month.

Meanwhile, in South Nunukan District, the source of income only comes from seaweed cultivation business income, which is the total average income in the last month of Rp. 6,870,000.00 per month. The smallest average income is IDR 3,000,000.00 per month, and the highest is IDR 10,000,000.00 per month. In detail, it can be seen in Table 2. In general, seaweed cultivation can be used as an economic instrument to reduce poverty levels and increase the income of fishermen's families, as has happened in other seaweed cultivation areas, both domestically and abroad, Malaysia, Philippines, Fiji [20-22]. Ecologically, seaweed cultivation can be used as an alternative income for fishermen to carry out fishing activities that can damage the environment [23].

3.3. Household Expenditure of Seaweed Farmers

Household expenditure is the total expenditure in one household consisting of food and non-food expenditures. On average, the largest type of expenditure for seaweed farmers in Nunukan District is for food needs at home, which is Rp. 2,270,000.00 per month or (51.51%), and sequentially followed by debt installments of Rp. IDR 1,000,000.00 per month or (22.85%), expenditure on eating and drinking outside the home is IDR 766,670.00 per month or (17.39 %), expenditure on cigarettes is IDR 640,390.00 per month or (14.53%), school children's snacks amounted to Rp 518,890.00 per month or
(11.77%), and expenses for transportation were Rp 332,410.00 per month or (7.54%). In total, the average expenditure is IDR 4,410,000.00 per month. According to Syaifullah, Eliza, & Tarumun [24], food consumption expenditure can be influenced by income levels, food prices, and household characteristics (age, type of work, education, and occupation).

The same thing happened to seaweed farmers in South Nunukan District, the largest expenditure was for food ingredients at home, which was Rp 1,230,000.00 per month or (33.65%), and expenditure for cigarettes was Rp 1,130,000.00 per month or (30.8%), expenses for eating and drinking outside the home of Rp 529,470.00 per month or (14.51%), expenses for transportation of Rp 435,390.00 per month or (11.93%), school children's snacks are IDR 390,200.00 per month or (10.70%). In total, the average expenditure in the last month was IDR 3,650,000.00 per month.

In terms of household expenditures for seaweed farmers, the demands for needs are still prioritized on basic needs and physical needs. This is also explained by Kurnia [25] that until now it is still difficult to fulfill the basic needs of border area communities. Meanwhile, social phenomena, both traditional society and modern society in general, are no longer just for survival, but all will always try to meet basic (physical) needs and advanced (secondary and tertiary) needs.

To measure poverty, BPS uses the basic needs approach concept. With this approach, poverty is seen as an economic inability to meet basic food and non-food needs as measured from the expenditure side. So "poor people" are people who have an average monthly per capita expenditure below the poverty line. The number of poor people in North Kalimantan in September 2017 was 48,560, of which, 11,910 people were from Nunukan Regency. The increase in poverty is due to the undeveloped economy of the people and a lot of money is saved or invested outside Nunukan. So it is necessary to pay close attention to the increasing economic income from the cultivation sector, especially seaweed cultivation, it is also advisable to increase investment and money circulation in the Nunukan Regency area.

3.4. Seaweed Capture Fishermen

The newest and unique phenomenon in Nunukan Regency is the existence of seaweed capture fisheries. This type of fishery refers to fishermen who use boats and fishing gear to catch seaweed in locations that are several meters (10 meters or more) away from seaweed farms or places where seaweed is washed away.

According to respondents, about 700 boats were converted from fishing to seaweed fishing (interview with fishermen, July 2018). The fishermen stated that this business was more profitable than catching small pelagic fish for several reasons: 1) the market for pelagic fish was already fulfilled in Nunukan Regency so that the prices for pelagic fish were sometimes unprofitable; 2) the price of seaweed is good for the market in Surabaya and Makassar. The good price of seaweed in the market is due to, among other things: 1) the seaweed trade chain in Nunukan is relatively short with a clear market, even many seaweed manufacturers from within and outside the country come directly to get guaranteed goods that can be sent to the factory or export quotas [2]; 2) the production and guarantee of seaweed in Nunukan Regency is relatively stable and continuous throughout the year, with several locations in Indonesia there is a decline in production and even production closes although the quality of seaweed must be considered (impurity levels, yield, gel strength) required by the factory or standard export request; 3) the demand for seaweed types of cotonii continues to increase both at home and abroad.

This seaweed capture fishery uses small boats measuring 1-2 GT to go to sea for about 1 day. In every day at sea, they bring 2-3 men in the ship. They can catch up to 2.5 tons of wet seaweed. With a ratio of 9:1 between wet and dry seaweed, each day seaweed fishing activity produces approximately 150 kg of dried seaweed. The price of dried seaweed in Nunukan Regency ranges from Rp. 8,000 – Rp. 12,000.00. From the qualitative survey, above average monthly net income can range between 4-5 million rupiah for small farmers and tens of millions for large farmers who have thousands of seaweed ropes and/or seaweed entrepreneurs/buyers.

The costs incurred for these fishermen include gasoline as boat fuel, cigarettes, and food brought from home. However, sometimes seaweed fishermen also have to replace damaged nets and broken propellers during fishing. This seaweed catch occurs in the season when there is a strong current. The
locals call it “water season”. The water season refers to the high tide when the current occurs from the sea to the coast. An interesting sharing scheme in seaweed capture fisheries involves sharing between the boat’s owner and the fisherman. For example, the owner of seaweed boat’s owner (usually called skipper) will get 1/3 of the profit and fishermen (1 or 2) will get 2/3 of the profit after deducting operating costs.

3.5. Seaweed Capture Fishermen Challenges and Conflict
Although the seaweed business is quite promising in Nunukan Regency, the threat of conflict occurs in the Nunukan waters, especially in the Sebatik Strait. Conflicts related to seaweed in Nunukan as challenges for seaweed development in Nunukan are:

1) Conflicts in the use of water space between seaweed farmers and fishermen with traditional and international shipping lanes. This type of conflict occurs because some farmers expand their cultivated land in shipping lanes, thereby violating the agreed areas during their agricultural expansion. This route is determined by the local sea transportation office. What's more, the expansion of seaweed farmers causes other problems, such as spatial conflicts among the seaweed farmers themselves. In general, no one has territorial waters in Lintas Sebatik. So, everyone can grow seaweed in the area.

2) Social unrest between seaweed capture fisherman/seaweed trawler and seaweed farmers. In the Sebatik Strait, there are many farmers in areas with strong currents, so the seaweed falls off the ropes and is carried by ocean currents into the surrounding waters. The fishermen pick up the loose seaweed from the ropes using nets that have been installed overnight. Then the nets that already contain seaweed are pulled from the nets and transported to land and dried.

Conflicts arise because of accusations or some people who sometimes incorrectly break or cut the seaweed rope so that the nets installed get more seaweed. Conflict areas usually occur near seaweed farms. Another problem for seaweed fishermen is the quality of seaweed caught under cultivated seaweed because of the non-uniform age [15].

The short-term solution is the importance of providing general education and awareness to coastal communities about the marine area zoning plan set by Nunukan Regency and North Kalimantan Province such as not to farm seaweed on the shipping lanes. In addition, norms and informal rules among fishermen who catch seaweed that divide their time to go to sea need to be discussed and agreed upon. The existing informal rules governing the distribution of area and time to minimize conflict will continue. Currently, seaweed fishermen agree on who goes to sea at night and who goes to sea during the day. This is done alternately and is quite effective in reducing tension among fishermen who catch seaweed themselves.

The local government resolve the conflict utilizing the Nunukan residents' meeting called "coffee morning". It is a semi-formal meeting place for all stakeholders of the seaweed business, including from the military sector in Nunukan. Problems are presented and efforts are sought by consensus for resolution between the various parties. This step needs to be continued periodically. The coffee morning event can also be used as a means of socializing location boundaries for seaweed farming businesses.

The medium term solution is to form a working group by involving related parties. These parties include the Marine and Fisheries Service, Environmental and Forestry Services, the Transportation Service, the Nunukan Pelindo Branch Office, cooperatives in the fisheries sector in Nunukan and Community Groups (Pokmas) to enforce the implementation of the coastal and island zoning plans. The last two groups, cooperatives and Pokmas, need to be encouraged to also be part of the monitoring, control, and zoning plans. Control is carried out especially for seaweed trawlers. This is so that the seaweed trawlers and seaweed farmers limit themselves not to carry out activities at night, other than to avoid unwanted events.

The working group is formed in order to design a social welfare development program that emphasizes the concept of aid and the concept of empowerment. The implementation of this concept is an effort to help the weak or powerless to be able (empowered) physically, mentally, materially, and mentally to achieve social welfare without going through any conflict.
4. Conclusion
As seaweed provides source of livelihood in Nunukan [26], therefore all types of conflicts that arise need full attention, both the resolution of conflicts that arise and their prevention by the local government and the seaweed business actors themselves. Therefore, we recommend several resolutions for conflict issues covering the short, medium and long term. The long-term solution is that the Coastal and Small Island Zoning Plan in the Sebatik Strait must be immediately upgraded to become a legal part of local laws or regulations that can be used as a legal reference for all entities.

Furthermore, a clear law is needed and a long-term roadmap for the management of the area needs to be formulated so that technical matters are designed and developed as a development program for the Nunukan Regency [27]. The Provincial Government together with the DPRD of North Kalimantan have established and disseminated Regional Regulation Number 4 of 2018, concerning the Zoning Plan for Coastal Areas and Small Islands of North Kalimantan Province for 2018-2038 which also regulates the use of marine space.

As the foremost and outermost area, Nunukan Regency, has new hope for its citizens, especially people who depend on fisheries for their lives, both as fishermen, seaweed fishermen, and seaweed farmers. Moreover, the area has fishery potential that can provide economic value and livelihoods for its people. Nunukan Regency is included in the State Fisheries Management Area of the Republic of Indonesia (WPPNRI) in accordance with the Regulation of the Minister of Marine Affairs and Fisheries (Permen KP) Number 18 of 2014 concerning the State Fisheries Management Area of the Republic of Indonesia.

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