Socio economic assessment of seaweed farming in Nunukan Regency, North Kalimantan

A Zulham, U Muawanah, N Shafitri, R A Wijaya

Research Centre for Marine and Fisheries Socio Economics, Jl. Pasir Putih I, Ancol Timur – Jakarta, Indonesia
E-mail: keude_bing@yahoo.co.id

Abstract. The high demand of seaweed had encouraged the farmers to expand their cultivation area, cause the spatial & temporal labor migration, water quality degradation, and destruction of the mangrove ecosystem. This research aims to provide information about seaweed cultivation in Nunukan for better management and planning for seaweed business sustainability. This research was conducted in April and May 2018 with 89 respondents. The result showed that the labor origin for seaweed farming mainly from South Sulawesi or from the illegal Indonesian Worker in Sabah - Malaysia. There are a big number of fishing boats capturing drifted seaweed in Ambalat and Karang Unaran water. This activity occurs due to the presence of “dead water” and “tide water” in Sebatik Strait. Seaweed farming cycle is about 35 days with an average number of ropes 500 – 600 per farm. There are 2,033 seaweed farms, which required 16,284 workers per year. The money circulation in seaweed business was estimated to be more than IDR 3.05–4.57 billion a month. This research recommends the local government to develop seaweed cultivation zoning to avoid conflict of sea area utilization and to improve marine water quality as well as to guarantee the sustainability of seaweed investment and business in Nunukan.

1. Introduction

The seaweed cultivation in Nunukan Island was formerly introduced by migrants from Bone - South Sulawesi in Mamolo - Tanjung Harapan Village in 2007. The success as described by Maunati [1] has made Nunukan Island with coordinates (04° 03' 04" Nort Latitute - 117° 04' 01" East Longtitude) and Sebatik Island (04° 07' 14" Nort Latitute - 117° 04' 01" East Longtitude) as a new area of hope to improve the economy of migrant households from South Sulawesi. This attributed by the households engage in seaweed farming in Nunukan Regency has increased from 548 households in 2015 to 649 households in 2017. There are several seaweed cultivation centers such as South Nunukan District (Mamolo Village, Tanjung Harapan Village, Sei Lancang and Sei Mengkudu); Nunukan District (Mansapa and Sedadap); Sebatik Barat District (Binalawan Village: Matingkas Village, Ujung Muara Barat Village; Setabu Village; Liang Bunyu Village: Tidung Village and Bugis Village) and Sebatik District (Tanjung Karang).

The cultivated seaweed is a type of Kappaphycus alvarezii (cottoni spp). This species grows well and can be planted for year round in Nunukan Island. In 2017, seaweed production reached up to 19,761 tons. In terms of production capacity, Nunukan Island is an important seaweed supplier for seaweed companies and processing in Makassar and Surabaya. In detail, 97.98% of the seaweed production in Nunukan came from Nunukan Island, while Sebatik Island only 2.02% of the total seaweed production in Nunukan Regency [2].

Seaweed business in Nunukan and Sebatik Island is an important livelihood for people living on the coast of the Sebatik Strait, because a) It provides income for workers who participate in seaweed business stages, namely: preparation, cultivation, harvest, distribution and marketing of seaweed; b) The ownership of the assets of seaweed farming in Nunukan Island continues to grow. On the average, each cultivator possesses 500-800 rope span of seaweed. ; c) Expansion of the seaweed cultivation
asset possession pushed the growth of seaweed production business facilities, induced spatial labor migration from South Sulawesi and Indonesian Workers from Tawau (Malaysia) to Nunukan, increase the number of temporary labor migration from oil palm plantations to seaweed business.

The seaweed cultivation business not only boosts the local economy but also has encouraged the emergence of problems in the Strait of Sebatik, such as conflicts of spatial use the waters between the seaweed farming and shipping lanes [3], expansion of drying field and residential units. These conditions cause the damage to mangrove area in South Nunukan and West Sebatik District and the decline in the quality of the waters in the Sebatik Strait due to sedimentation and dynamics of ocean currents.

Some reports suggest the seaweed cultivation business can be used as an instrument for poverty alleviation such as in the Philippines, and Malaysia [4], also an alternative livelihoods for fishermen using destructive fishing gears [5], potential source of income and employment for rural communities [6], using simple technology with cheap investment, therefore, can be part of household business [7]. For instance, a worker who ties the seaweed seedlings receives an average of IDR 150,000 each day. A worker who takes part in the drying stage of seaweed receives IDR 500/kg dried seaweed. If the worker can dry up to 1-2 tons of seaweed in 3-4 days, he may receive IDR 500,000 – 1,000,000.

Therefore, information on socio-economic aspects of seaweed cultivation, in Nunukan and South Nunukan District (Nunukan Island) needs to be understood for better management and planning for seaweed business sustainability. Seaweed business in Nunukan can provide employment opportunities for illegal Indonesian workers in Sabah, sources of household income as well as the potential for the growth of new businesses in Nunukan.

2. Methodology

2.1 Data Sources & Period of Data Collection

The data used in this paper were collected from the survey of the Integrated Marine and Fisheries Programme in Sebatik. The study was conducted at the seaweed production center in South Nunukan District (South Nunukan Village, Sedadap Village and Tanjung Harapan Village) and Nunukan District (West Nunukan Village, Central Nunukan, East Nunukan, and North Nunukan). Interviews were conducted from April 27 to 22 May 2018 using random sampling. 44 respondents were interviewed in South Nunukan and 45 respondents in Nunukan. Other data sources were obtained from key informants who knew about the seaweed business in Nunukan. In addition, secondary data were obtained from various publications related to seaweed cultivation in Nunukan.

2.2 Data analysis

The obtained data were analyzed by descriptive and prescriptive [8, 9, 10] analyses. Results were presented in the table based on the topics. Descriptive analysis explained the phenomenon in seaweed business in Nunukan, while prescriptive interpreted the information from descriptive analysis to formulate the strategy of the business development.

3. Results and Discussion

3.1 Business Characteristics of Seaweed Cultivation

Nunukan Island is a new area of hope to improve the standard of living [1]. From the total population of Nunukan Regency (193,390 inhabitants); 12.71% are in South Nunukan District and 35.59% in Nunukan District, the rest are spread in 11 other districts between 1.02% to 6.88% and more than half Nunukan Island residents are migrants mainly from South Sulawesi.

In Nunukan Island with rich natural resources, the cultivation of seaweed is the most popular business now. This business can be done with an initial capital of IDR 10 - 13.3 Million. This condition encourages migrants from outside the region to come to Nunukan Island to participate in cultivation seaweed. Dominant ethnicities in seaweed cultivation activities in Nunukan Island are Bone and Bugis tribes from South Sulawesi (Table 1).
Table 1. Distribution of seaweed farmers and its ethnics in Nunukan Island, 2018

| Ethnicity       | District (%) | Nunukan | South Nunukan |
|-----------------|--------------|---------|---------------|
| Bone            | 6.7          | 90.9    |               |
| Bugis           | 75.6         | 2.3     |               |
| Buton           | 2.2          | -       |               |
| Mandar          | 6.7          | 6.8     |               |
| Java            | 2.2          | -       |               |
| Kutai           | 2.2          | -       |               |
| East Nusa Tenggara | 4.4    | -       |               |

Table 1 shows the high population of the Bone tribe in South Nunukan and the Bugis tribe in Nunukan is due to the social networks of the two tribes. It is understood the employment of labor was based on the tribe's relatives, which it means hiring members within the same tribe. This social network encouraged the Bone and Bugis tribes from South Sulawesi to come to Nunukan to work in seaweed cultivation. The social network also recruits Indonesian Illegal Workers in Sabah from South Sulawesi back to Nunukan to cultivate seaweed. Approximately 60.2% of seaweed workers and cultivators in Nunukan had worked in Sabah, Malaysia.

The technology of seaweed cultivation that developed in Nunukan Island is a long line with an underwater construction system. Seaweed cultivation is growing rapidly because the owners of investment make a profit sharing agreement with the labor who involve in seaweed farming. In general, one-third of the seaweed cultivation goes to the workers. For instance, if the cultivator has 1000 ropes, the workers entitle of 300 ropes. This profit sharing system has helped accelerated the need for seaweed cultivation on the island of Nunukan.

Characteristics of seaweed cultivation in Nunukan Island can be studied in Table 2. It shows the average age of seaweed farmers is 38.6 years in Nunukan and 38.3 years in South Nunukan. The education level of respondents generally did not pass junior high school, which characterized as 8.2 years and 8 years in Nunukan and South Nunukan. However, on average the farmers have experienced about 7 years and more in seaweed cultivation which is an important factor in supporting seaweed cultivation in Nunukan. This indirectly has contributed to the total ownership of long line (ropes) for seaweed farming which it was found an average of 821 units in Nunukan District and 536 units in South Nunukan District per household.

Table 2. Characteristics of Respondents in Nunukan and South Nunukan Regency

| Characteristics                                  | Districts            |
|--------------------------------------------------|----------------------|
| Age (year)                                       | 38.6                 | 38.3                 |
| Education (Years)                                | 8.2                  | 8.0                  |
| Experience (years)                               | 7.3                  | 7.0                  |
| Number of seaweed rope cultivation (units)        | 821                  | 536                  |

3.2 Challenges of Seaweed Cultivation Development

Seaweed farming is advanced in Nunukan District (East Nunukan Village, West Nunukan Village, Central Nunukan Village, and North Nunukan Village) and South Nunukan District (South Nunukan Village, Sedadap Village and Tanjung Harapan Village). This cultivation effort has been
developed in the Sebatik Strait around 3 - 4 Km off coastline [11]. However, a certain bounded water area will have certain or limited environmental carrying capacity. If the carrying capacity exceeded, that could lead to the emergence of conflicts over space use, cause damage to mangrove forests in Nunukan Island and the decline in the quality of waters in the Sebatik Strait that will lower the seaweed yield. Lower environment carrying capacity indirectly has reduced the number of households (RTP) engaged in farming in South Nunukan District from 1,633 households in 2015 to 990 households in 2017.

Table 3 shows the estimated development of seaweed cultivation in Nunukan Island in 2018 with the total long lines (ropes) of seaweed cultivation in Nunukan District is 532,829 units and in South Nunukan District 530,640 units. The unit of cultivation is called “bentang” or “line” whereas each line acts like a standing rope bolstered on both ends with long standing woods and stucked in the bottom of waters. One line unit has an average length of 30 meters. Thus, the presence of too many seaweed ropes in the Sebatik Strait waters encourages the emergence of space use conflicts. Another conflict also occurred between shipping channel users (commercial vessels, fishing boats and passengers) with the location of seaweed cultivation. Efforts to overcome the conflict have been carried out by the Nunukan Regency Fisheries Office and the Nunukan Regency Transportation Agency, the Environment and Forestry Service and the Nunukan Branch Pelindo. The Zoning Plan for the Coastal Zone and Small Island (RZWPPK) tried to solve the conflict [3].

| Description                                      | Standard | Districts |
|--------------------------------------------------|----------|-----------|
| Number of households in seaweed production        | Household| Nunukan 649, South Nunukan 990 |
| Average number of seaweed lines per RTP           | Unit     | Nunukan 821, South Nunukan 536 |
| Total number of Seaweed per line                  | Unit     | Nunukan 532,829, South Nunukan 530,640 |
| Dried-Seaweed Production / HH/ Year               | Kg       | Nunukan 26,670, South Nunukan 13,286 |
| Total Estimated Dried-Seaweed Production          | Kg       | Nunukan 17,308,830, South Nunukan 13,153,140 |
| Labor per year                                    | Person   | Nunukan 9,852, South Nunukan 6,432 |

Note: Households number data from Fisheries Office in Nunukan (2017)

To overcome the conflict of spatial use in Sebatik waters, it must involve related agencies such as the Seaweed Bahari Border Cooperative (Koperasi Rumput Laut Bahari Perbatasan) in Mamolo - Tanjung Harapan Village, as well as the community watchdog group called Pokmaswas. Both of these organizations need to be strengthened so that their functions can oversee the use of sea space by seaweed farmers. Thus the seaweed cooperatives in Nunukan and South Nunukan Districts do not only function as a place for recipients of government assistance but also play a role in supervising the utilization of marine space by farmers.

Sebatik Strait water is a narrow strait with a width between 3-4 Km from the coastline. This straight is impacted by the tides of the Makassar Strait. In Sebatik, there are two kinds of waters, so called “dead water” and “tide water” according to local communities. The "dead water" is a community term that shows weak ocean current occurring twice a month for 3 - 5 days and "tide waters" is strong ocean current occur once a month for 7 to 10 days. This strong current condition many times causes the seaweed to fall off from their ropes or lines. In South Nunukan District, there are estimated about 532,829 seaweed ropes and 530,640 seaweed ropes in the Sebatik Strait waters. This has led to a new occupation called seaweed fishers.
Spatial labor migration and additional volumes of seaweed identified as drivers for the demand for space for living and seaweed drying floors. To meet the needs of the space, the community uses the mangrove area to expand the floor of dried seaweed and residential homes for migrant workers in the center of seaweed production. The damage of mangrove area found to be in Sedadap Village, Mamolo - Tanjung Harapan Village, Binalawan Village, and Setabu Village. This needs a proper attention from local government and enforcement that certain percentage of mangrove area need to be protected.

The high number of seaweed ropes in the Sebatik Strait caused a decrease in the quality of waters in the area. This is evidenced by the level of brightness of the waters around Nunukan and South Nunukan Districts ranging between 75 cm and 90 cm. However, previous research on these two locations shows the same level of brightness of the waters ranging from 2 to 5 m with a current of 20 to 40 cm per second in 2012 [12]. This shows that seaweed cultivation at some extend has lower the marine environment quality due to intensive activities in the water, sedimentation from the hinterland and high nutrient in the waters. This also caused the growth of a certain number of blood clams (Anadara granosa) and will danger seaweed harvest.

The development of seaweed and the high demand for labor in seaweed business in Nunukan Island caused the turnover of money in Nunukan approximately IDR 3.05 to 4.57 billion per month. This seaweed business is a very promising economic activity and the spill over impact of it would boost broader economic activities in several Nunukan District.

4. Conclusions
The cultivation of seaweed (Kappaphycus alvarezii) is well developed in the Sebatik Strait waters is determined by the suitability of the water conditions especially nutrients and sea currents. Seaweed cultivation in Nunukan Island contributes significantly from economic perspective due to market demand and favorable prices. The existence of blood clam and stealing activities of seaweeds in a farming location, however, decreasing the number of households involved in seaweed cultivation.

The high utilization of space for seaweed cultivation is also influenced indirectly by the high price of seaweed in Nunukan. However, the RZWPPK is difficult to implement, therefore the conflicts over space utilization in the waters continue to happen until this time. Some stakeholders need to be involved in the implementation process of coastal zoning.

Therefore, to maintain the seaweed cultivation in the Sebatik Strait, in the short term it is necessary to establish a working group involving local government agencies and communities such as Fisheries Service - Environment and Forestry Service - Transportation Agency - Pelindo Nunukan Branch - Cooperative Fisheries in Nunukan and Pokmaswas. This working group is to enforce the implementation of the Coastal and Island Small Zoning Plan and encourage fisheries cooperatives and Pokmaswas to also be part of monitoring, control and surveillance of zonation plan.

In the long term, the Coastal Zone and Small Island Zoning Plans in Sebatik Strait should be upgraded into a legal piece of local laws or regulation that can be utilized as a legal reference for all entities using or having business in Sebatik Strait waters. The legal regulation will be able to overcome the problem of environmental damage, the Sebatik Strait sea space use conflict and control the destruction of mangrove forests on the coast of Nunukan Island and Sebatik Island.

Acknowledgement
We thank the Research Center for Socioeconomic of Marine and Fisheries for funding the research. We also would extend our gratitude to our field assistants for their times helping with data collection, to the fishers and key respondents that we had interviewed. We thank PICs of SKPT Nunukan in DGCF in MMAF office in Jakarta.
References

[1] Maunati Y 2009 Etnisitas di Nunukan dan Sebatik, dalam Ardhana, et al., Etnisitas Pengembangan Sumberdaya Lokal dan Potensi Perdagangan Internasional dalam Rangka Peningkatan Kesejahteraan Masyarakat Nunukan, Kalimantan Timur. Jakarta. LIPI Press

[2] Dinas Perikanan Kabupaten Nunukan 2018 Lalu lintas rumput laut di Kabupaten Nunukan. Nunukan

[3] Radiarta I N, Erlania J, Haryadi, Rosdiana A 2016 Jurnal Kebijakan Perikanan Indonesia 8(1) 29-40

[4] Simbajon R S, Ricohermoso M A 2001 Developmen in Seaweed farming in Southeast Asia. In L.M.B. Garcia (Eds). Responsible Aquaculture Development In Southeast Asia. Proceedings of the Seminar –Workshop on Aquaculture Development in Sotheast Asia organized by the SEAFDEC Aquaculture Departement, 12 – 14 Oct. 1999, Iloilo City, Philippines. SEAFDEC. p 99 – 102

[5] Zamroni A, Laoubi K, Yamao M 2011 The development of seaweed farming as asustainable coastal management method in Indonesia: an opportunities and constrains assessment. WIT Transactions on Ecology and the Environment. WIT Press. Vol (150). p 505-516

[6] Ram V 1991 The Seaweed industry in Fiji, with special reference to Euchema (Rhodophyta). Univ. of New South Pasific, Marine Studies Programme. Technical Report. 1991 (2)

[7] Lal A, Vuki V 2010 Fisheries Information Bulletin 111 11 – 16

[8] Huisman D O 2015 To what extend do predictive, descriptive and prescriptive supply chain analytics affect organization performance?. 5th IBA thesis conference 2 July 2015. (p.8). The Faculty of Behavioral, Management and Social Sciences. Univ. Twente. Netherland.

[9] de andLange G 2017 Understand Prescriptive Analytics in 20 Minutes. AIMMS.Connecting Business Optimization

[10] Heaney B 2015 Supply Chain Intelligence: Descriptive, Prescriptive and Predictive Optimization. ABERDEEN GROUP. A Harte Hank Company.

[11] Siburian R 2012 Jurnal Masyarakat dan Budaya 14(1) 53-75

[12] Reski 2012 Impact of Development of Seaweed cultivation in Nunukan. Thesis Univiversitas Terbuka Jakarta