

Vulnerability and Livelihood Adaptation Strategies of Small Island Fishers under Environmental Change: A Case Study of the Barrang Caddi, Spermonde Islands, Indonesia

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Abstract

The changing climate brings various challenges to the fisheries industry, especially to those who depend their livelihood on fish in the small island. Through selective adaptation and mitigation strategies, many households may survive facing the unpredicted climate and weather conditions. Here we study how a small-scale fishers household in Indonesia struggled and searched their ways to face climate change which often resulted in a decrease in catch and income. Using a collective method of quantitative and qualitative, the study showed that the livelihood vulnerability level of Spermonde fishers is 0.56 (highly vulnerable). Three adaptation mechanisms such as ecological, economic and social, were discovered. The fishers often change their fishing ground location and add more fishing gear to catch the declining stock of fish or to make it easier for them to fish in the unpredicted weather. They used an 'intensification' strategy in dealing with climate change effects. This strategy is chosen due to the limited capital they have and a full dependency on the natural resources (fish) as their main source of food and income.

Keywords

fishing, livelihood, Spermonde Islands, Indonesia, environment, climate change



1. Introduction

Fisheries is one of the important resources for livelihood in many countries which provides jobs, income and food security. The current fisheries provide employment for approximately 59.5 million people in the world where 85 percent of fishers and fish farmers inhabited the Asian region (FAO 2020). In terms of food supply, fish provides over 15 percent of global protein needs as part of total annual trade exceeding US\$55 billion (Ormerod 2003), and in 2018 the total export value of fish reach US\$164 billion (FAO 2020). However, most governments in developing countries disregard this sector, even though it has proved to be a sector that could achieve economic growth and alleviate poverty (Thorpe et al. 2005).

As an archipelago state, Indonesia relied on the fish as a source of protein, income and employment. The people of the Spermonde Islands heavily depend their lives on fishing (*fish for livelihood*). Their main occupations are dominantly fishers and they are known to have no other side occupations. Having the sea as their main source of livelihood, it can be said that the people of the Spermonde Islands are full-time fishers whose entire working time is used to carry out fishing operations (Directorate General of Fisheries 2000). This is influenced by the geographical conditions of the islands having sandy beaches with no land that is useful for farming (arid land). Having only educational background in elementary school is also one of the reasons why the fishers in Spermonde Island do not have other side occupations. Small-scale fishers are constrained by the lack of geographic mobility and access to other alternative livelihood activities (Abdulai & Croleress 2001; Panayotou 1982 in Yuerlita & Perret 2010). Thus, when small-scale fishers are said to be poor, it is understood as they are poor because of their lack of access to alternative employment opportunities (Chowdury et al. 2011).

The small islands, such as Spermonde, face some exacerbating issues including degradation of natural resources, poverty, conflict and the vulnerability to global environmental change. Many fishery resources were predicted in a state of crisis due to the heavy exploitation and failure in the fisheries management regime (Pauly et al. 1998; Dulvy et al. 2003; Suadi and Nakagawa 2008). Besides the poverty level of the people who rely on the coastal resources such as fisheries is also predicted to be the worst due to the degradation of the natural resources (Béné 2001). Therefore, the promotion of livelihood sustainability for such a small island is needed. *Livelihood* in this context might be defined as the people's activity, the resource that provides them with the capability to build satisfaction of living, the risk factors that they must consider in managing their resources and the institutional policy context that either help hinders them to pursue a viable or to improve their quality of living (Ellis and Freeman 2005). The livelihood variable comprises people, their capabilities, and their means of living including food, income and assets (Chamber and Conway 1992). This study aims to identify livelihood assets, vulnerability, and adaptation strategies for small island communities in Spermonde Island, Makassar City, Southern Sulawesi, Indonesia.

2. Research Framework and Method

2.1 Study location

The research was conducted on the island of Barrang Caddi, Spermonde Islands, Makassar City, South Sulawesi Province. This location was chosen because the island is close to one of the big cities in Indonesia, making it possible to analyze how the livelihood strategy of small island communities particularly related to the mobility of island

communities to the natural resources around them. Scoones (1998) framework mentioned that migration is one of the alternative livelihood strategies of community.

The Barrang Caddi Island is one of the administrative areas included in the Spermonde Islands, Makassar City, with an area of $\pm 0.57 \text{ km}^2$. The island is located in the coordinate of $5^{\circ}12'50.70'' \text{ S}$; $119^{\circ}34'20.67'' \text{ E}$ (Figure 1), the area is directly adjacent to the city of Makassar, which forms as the economic center in South Sulawesi makes the territorial waters of this island as an exit and entry route and increase the interaction of the island community with the city center. The population of Barrang Caddi Island in 2020 is 1,452 people with 382 households. This population has decreased compared to the previous year (2019) which had a population of 1,532 people and 333 households (Central Bureau of Statistics Makassar City, Barrang Caddi Village, 2021). This small island has a relatively high population density, causing problems related to the availability of land, water, and the environment.

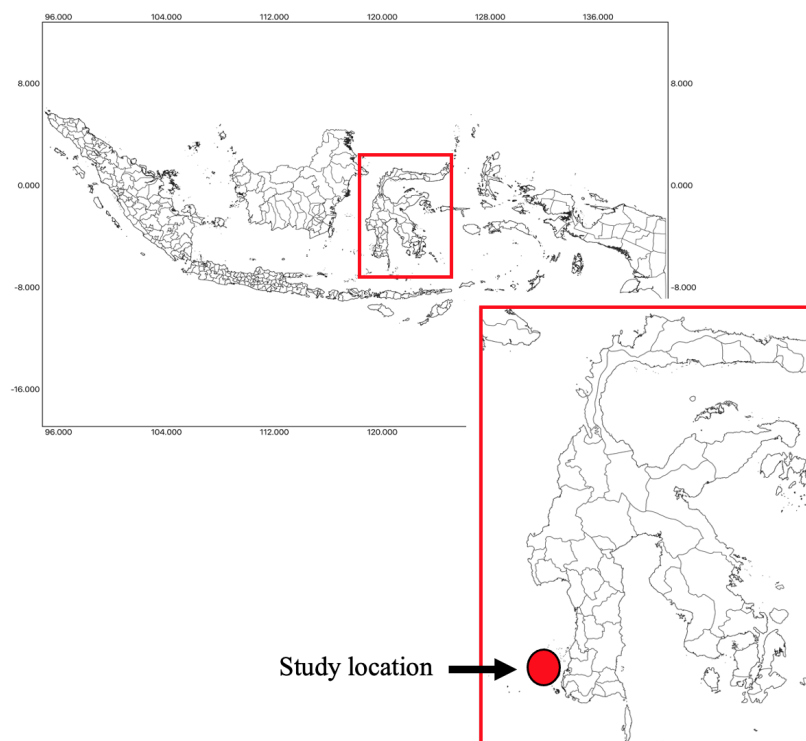


Fig 1. Map of study location in Barrang Caddi Island, Spermonde, Indonesia.

2.2 The profile of Spermonde Islands based on surveys: fisher community, climate and socioeconomic

Fishers on this island are generally hand-line fishers. They were classified as small-scale fishing households due to their limited capital ownership, with a boat size of 5-7meter length, a sailing distance of 2-3 miles and high-level-selectivite fishing gears. Such a small-scale fisheries sector is characterized by its limited capital, and relatively small boat size, with the boat owners, also doing the sailing (Allison & Ellis, 2001). Satria (2015) adds that the characteristic of small fishers includes sailing distance that is near to the beach and labour-intensive.

The small-scale fishers of Spermonde island consist of owner fishers and mustard fishers. The first are those who have their own boats to catch fish, while the later are those of the boat crew members (called by *ABK*) or who assist in operating the fishing gear while sailing or else, called as the fishing labourers. The survey results showed that out of 60 respondents are boat owners and mustard fishers with a total of 38 people (63%) and 22 people (37%), respectively (Table 1). Most of the households on the island are owner-fishers, which indicates that small-scale households have good access and control to fishing gear and boats. However, the capital for each fishing operation still significantly depends on the so-called *punggawa* (the collecting traders/middlemen).

Table 1. Summary of the characteristics of the respondent in Spermonde

| Characteristics | Mean | Percentage (%) |
|-------------------------------------|-------------------|----------------|
| Age (years) | Productive age | 96.7 |
| Education | Elementary School | 53.6 |
| Numbers of family members (persons) | 6 | 53.4 |
| Boat owner (persons) | 38 | 63 |
| Side occupation | None | 100 |
| Trip duration/days (hours) | 12 hours | 63 |

The climate pattern on Barrang Caddi Island is influenced by two seasons, namely the west (rainy) season and the east (dry) season. The west monsoon lasts from November to mid-April where rainfall is high and strong winds tend to blow from the southwest to the northwest as well as big choppy sea conditions that come from the southwest. The East Season lasts from May to mid-October where the weather is dry/dry and the wind blows from the Southeast to the East and the waves are relatively large from the East to the Southeast but not as big as during the West monsoon because of the protection from the mainland (Sulawesi Island). The average humidity is around 89.20% with 2729 mm of rainfall (Paotere Maritime Meteorology Station, 2009). The type of tide in the waters of Barrang Caddi Island is diurnal tide. The maximum high tide is 170 cm and the lowest is 30 cm. The current speed of Barrang Caddi Island ranges from 0.20-0.26 m/s.

The condition of nature and seasons play an essential role in the income of the fishers. Their average daily working hours, called *one-day fishing*, due to their limited boat capacity and operating capital, are 12 hours/day. The fishers of the Spermonde Islands, particularly in Barrang Caddi island prefer not to go fishing during extreme weather, such as strong winds and storms. Most of them experience seasonal income scarcity in November and December. The burden on small-scale fishers in Barrang Caddi Island is getting bigger due to overexploitation of the surrounding waters and the decreasing quality of the aquatic environment due to municipal waste, including from marine transportation activities.

Environmental conflicts due to urban development are also faced by the Barrang Caddi Island community. In the period from 2017 to 2019, the existence of sand mining activities for the need for stockpiling reclamation land in the Makassar City area caused an open conflict between fishermen on Barrang Caddi Island and fishermen on other surrounding islands such as Kodingareng Lompo Island and fishing communities on the coast of Galesong, Takalar Regency. (main island) with marine sand mining vessels that carry out these activities. The mediation process carried out by the South Sulawesi provincial government was able to reduce the conflict and the absence of sand mining activities provided more benefits and opportunities for fishermen on Barrang Caddi Island to be able to carry out fishing activities properly.

2.3 Study methods and framework

The idea of sustainable livelihood is now rapidly growing as a framework and approach to rural development policy and practice (Allison and Horemans 2006). As a framework for analysis, sustainable rural livelihood starts with an analysis of the existing conditions, trends and assessment of policy setting or environmental surroundings. The second step of analysis is the assessment of livelihood resources including the trade-off, combination, sequences, and trends. The livelihood resources or assets are consisting of human capital, natural capital, financial capital, social capital, and physical capital. This analysis is followed by the determination of institutional/organizational influences on access to livelihood resources and composition of livelihood strategy portfolio and followed by the analysis of livelihood strategy portfolio and pathways (Scoones 1998). Vulnerability context may include in this analysis in which vulnerability determined as to propenes to a sudden catastrophic, fall in the level of viability, usually interpreted as access to enough food for survival (Ellis and Freeman 2005).

Vulnerability indicators are studied in this study because small islands are often highly vulnerable areas due to its isolated environment or the influence of global environmental change. These indicators provide an overview of potential vulnerability over time, identify the cause that contributes to vulnerability, prioritize strategies for reducing vulnerability and evaluate the effectiveness of the strategy in different social and ecological settings. Vulnerability in this context adopts Adger's (2001) definition as a pressure from external factors, usually changes in the physical environment that requires adjustment or adaptation of people's livelihoods (Adger and Kelly 2001). Thus, we define vulnerability as a response to how vulnerable small island fishers are, to shocks and crises. It is a function of several components including exposure, exposure sensitivity and adaptive capacity, sensitivity and adaptive capacity (Adger and Kelly 2001; IPCC 2001). Exposure is an external factor that damages the physical condition of the source of livelihood. Sensitivity is an internal factor that comes from within society in facing pressure. Adaptive capacity is the ability of society to adapt by utilizing various resources in the face of a crisis (Adger and Kelly 2001; Shah et al. 2013).

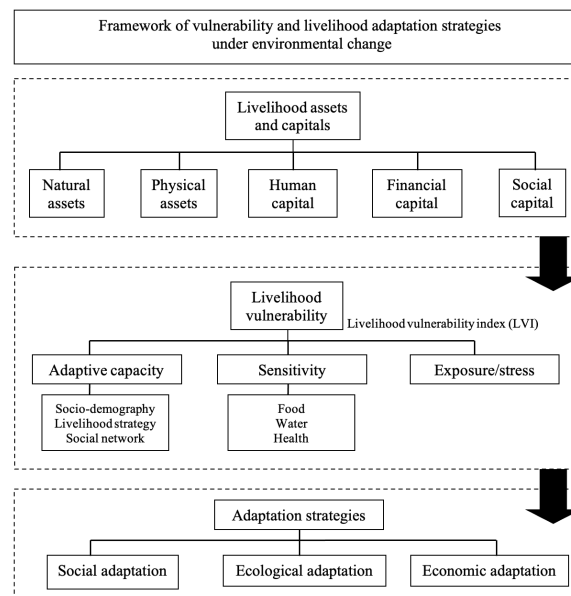


Fig 2. Framework on vulnerability and livelihood adaptation strategies in this study.

This study examines the vulnerability of fishers on the island of Spermonde based on an empirical study of the livelihood vulnerability index (LVI) which is divided into three categories; the vulnerability index of livelihoods from social, economic and ecological aspects (Figure 2). Primary data in this study were obtained by survey using a questionnaire. The questionnaire used is a questionnaire related to livelihood assets, vulnerability and adaptation strategies, which are then used to compile the Livelihood Vulnerability Index from the IPPC (IPCC 2001). In this study, LVI-IPCC was scaled from -1 (least susceptible) to 1 (most vulnerable) (Shah *et al.* 2013). Secondary data obtained are also used as a complement to strengthen primary data. The data obtained through questionnaires were processed using Microsoft Excel and analysed using SPSS.

Respondents in this study were fishery-related business actors in Barrang Caddi Island, both those who carry out business on the upstream side, such as fishers, fish farmers, processors on the handling and processing side and traders on the downstream side. Respondents were determined by the snowball sampling method (Somekh and Lewin 2005), in accordance with the research objectives and the target respondents. Key informants, particularly local leaders were also interviewed to collect more deep information. The survey was conducted for three months between May to July 2019 interviewing 60 respondents.

3. Result and Discussion

3.1 Analysis of the livelihood assets

The fisher households in Spermonde island utilize five livelihood assets/capitals to survive and/or obtain a better life. The natural asset includes the level of availability of fish, water and land resources. Physical asset includes the level of availability of boats, fishing gear (ATI), and fishery production infrastructure. Human capital includes the availability of the number of people and skills. Financial capital includes the level of availability of cash-conversible savings or goods. Social capital includes social relationships and employment networks. Availability of natural capital consists of fish resources that can be used to pay for their needs for food, to be their source of daily income, and to provide clean water for their vital daily needs. Clean water around the coastal settlements is quite scarce that people must either buy freshwater or process the seawater to be used for their daily needs. Social capital, which is useful to increase their survival competence, depends on the networks they have such as relatives, neighbours, formal and informal financial service cooperatives and religious institutions.

The five livelihood capitals can also measure the livelihood resilience (livelihood capacity to cope with pressures and disturbances) which is characterized by the capital and strategies of the fisher households to maintain and increase their capital. According to Allison and Horemans (2006), access and activities to the capital are either activated or hampered by the policies, institutions and processes, including social, market and organizational/institutional relations. The interaction between access and capital can be described in the terms of an “asset pentagon”. It shows that the centre point of the pentagon is the zero point of access and capital. Meanwhile, the outermost point of the pentagon angle is the maximum ability to access and obtain the livelihood capital (DFID, 1999). The following is a pentagon chart of ownership and access of Spermonde fishers to the five livelihood capitals (Figure 3).

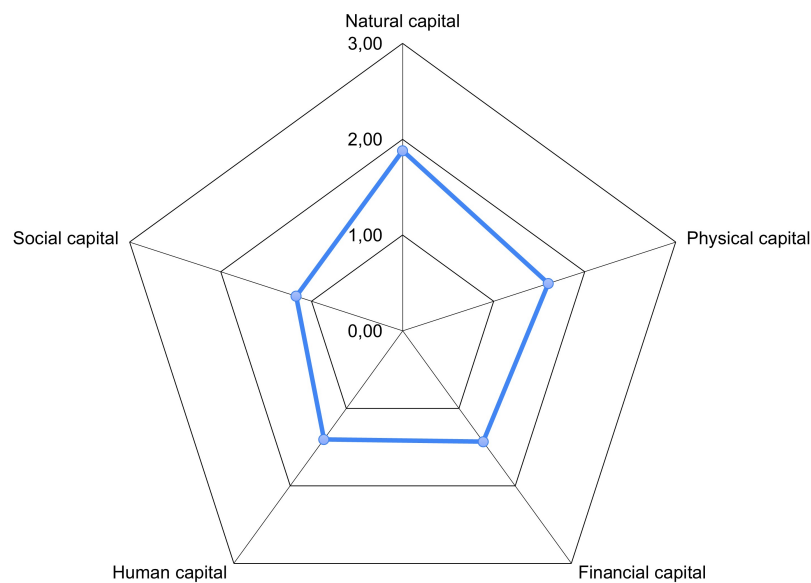


Fig 3. Five livelihood assets/capitals of the Fisher Households in Spermonde.

Figure 3 shows that the natural capital, physical capital, and financial capital of the Spermonde fishers are high. Natural capital, such as fish for the main source of food and income for every household. Physical capital includes ownership of boats and fishing gear. Even mustard fishers who do not have boats can access them through the *Punggawa* under certain terms and agreements. Likewise, other physical supporting assets/capitals for livelihood activities include fishing gears (GPS, FADs, and fish finders). The financial capital owned by fishers includes savings in the form of cash and gold jewellery. Based on the survey results, fishers in Spermonde admit that they do not have savings in formal financial institutions, such as government, private banks, or pawnshops. They prefer to take debt to non-formal financial institutions, such as *punggawa*, due to the easy access and time flexibility, especially during the income-scarcity seasons. The human capital includes their ability to sail and fish by using their fishing gears. Some of the working fishers are not only the head of the family or fathers but also their children who have entered the productive age of 17 years and older. In addition, the women have also skills in fish processing such as shredded fish and fish balls production. However, the use of their skills has not been optimal because they are used only at certain times or in incidentals.

Meanwhile, the social capital shows the lowest value due to the fisher groups and their members being inactive in every meeting. The lack of networks is caused by their high dependency and trust in the *punggawa* in addition to the local regulations not being applied and the absence of leadership function that led to mutual cooperation activities, which actually can ease the livelihoods of the fishers, especially when facing difficulties such as during income-scarcity time, are only very few. There are no institutional roles that can activate social capital and other livelihoods. The ownership of livelihood capital affects the resilience level of the fishers in maintaining their livelihoods from pressure or disturbance (vulnerability context).

3.2 Livelihood vulnerability context

Livelihood sustainability is also influenced by external factors. The livelihoods of the people and the availability of livelihood capital are affected by changes such as shocks and seasons, in which it is only limited or even zero control (DFID, 1999). Such pressures can be in the form of ecological, economic, and social exposure. Seasonal disruptions can

take the form of shifts in prices and occupational opportunities. Spermonde fishers must cope with various pressures on their livelihoods. They are generally faced with the same pressures, both natural exposures and socio-economic problems. These pressures and constraints affect their income because their livelihood depends only on the sea, particularly fish, which provides uncertain results. Weather conditions and the magnitude of the waves or storms, the availability of fish stocks in nature is classified as natural exposure. Most respondents (95.08%) stated that extreme weather was a pressure threatening their income. The details of the exposure faced by the Spermonde fishers are presented in Figure 4.

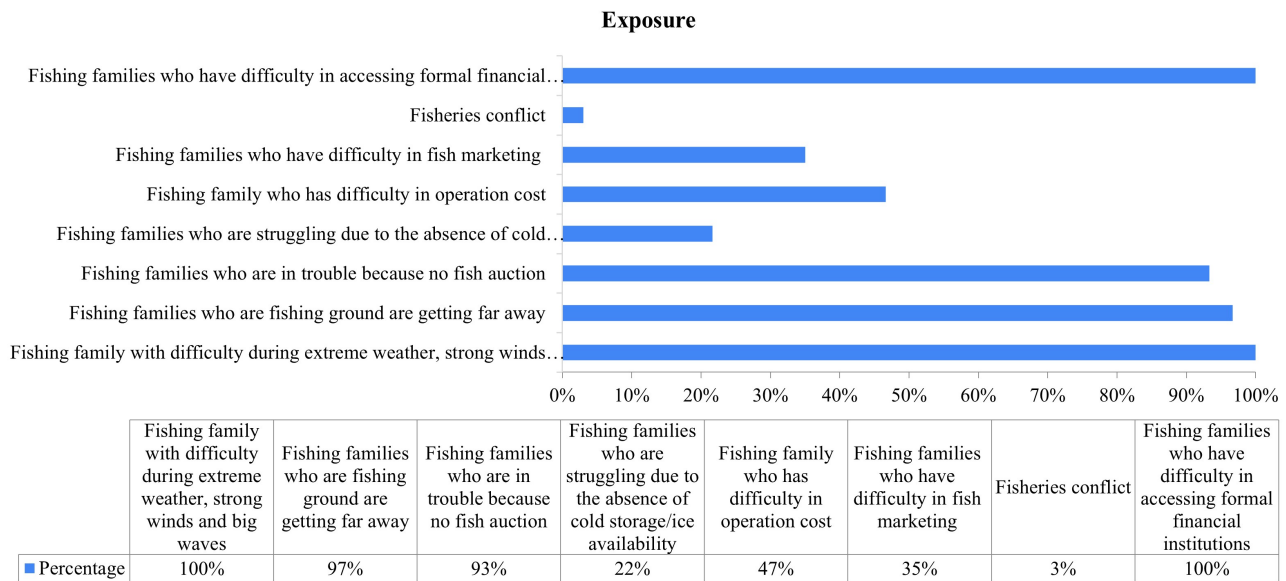


Fig 4. Exposures faced by Spermonde fishers.

Most of the sources of vulnerability faced by the Spermonde fishers come from ecological exposure or nature. Their income structure depends significantly on the abundance of fish resources in the area as indicated by the income distribution, which is dominated by the fisheries sector. Such high dependence on the fisheries sector, which is the automatic fishing, brings the impact of large ecological pressures on them. Ecological exposure is a type of pressure on the livelihoods that is difficult to control due to the fisher's limited ability, in addition to beyond-control conditions of weather and nature. One of the problems identified in this sector is the high dependence on fishery resources that leads to overexploitation which then results in a declining annual catch. This condition is worsening due to other external factors such as fluctuated market prices, limited access to credit facilities, and lack of knowledge improvement and facilities for fish processing and conservation (Chowdhury et al., 2011). A potential decline of fish stocks occurs as it is acknowledged that Spermonde fishers do not have other occupations. Their income highly depends on fishing activities. Therefore, most of the Spermonde fishers also try to extend their fishing ground farther to maximize their catch. Because the distance of the fishing ground is directly proportional to the operating capital required, it has also become a livelihood pressure for some fishers who experience capital difficulties.

The patron-client¹ system plays an important role in capitalization because it functions as one type of social and economic security institution for Spermonde fishers, especially for mustard fishers. Such a patron-client relationship between the *punggawa* and mustard fishers is a common phenomenon. The bond with the patrons is an important step in maintaining the continuity of fishing activities. According to Satria (2015), such practice occurs until now because

fishers do not have an institutional alternative that can guarantee their socioeconomic purposes. Patrons are people with higher financial capabilities, while clients are people who naturally depend on the patron in fulfilling their life needs. In this study, a patron is the *punggawa* and the client is the mustard fisherman and or the boat crew. The patrons play the role as the buyer for the catch of the fishers who have become their clients. The clients must sell their catch only to the patrons who have lent them the capital for sailing.

Patron-client bond is carried out in various activities such as marketing activities related to the financial dependency factors, production activities related to fishing gear selection, and social leadership in the community life. It occurs due to the fishers being unable to provide themselves with the capital to carry out fishing activities. The capital needed includes the cost of boat fuel and consumption, as well as their household or family life necessities. It is also related to the fishing ground or location. When the mustard fishers also have a debt to the *punggawa*, then their income from fishing will be automatically deducted to pay their debt first. This will decrease their income and not worth the efforts they have spent. The deducted income depends on the amount of the loan and the agreement. The fishers will continue to market their catch to the *punggawa* until all their debts are fully paid off. This will be quite difficult for some fishers considering that their income will continue to decrease because apart from paying the debt, they also have to share their income with the crews. When such a pattern continues, their financial dependence on the *punggawa* will be automatically established. Thus, due to their low income, small-scale fishers are often associated with the term of poverty. However, Salas *et al.*, (2011) give a different statement, that fishers cannot be considered poor as long as they can have access to the fisheries sector, catch their crops and have their daily needs fulfilled despite being vulnerable to dangers and pressures. According to Miñarro *et al.*, (2016), the patron-client system also influences the fishing behaviour to be less diversified and increases the focus of fishers on commercial fishing. This is not the case for independent fishers without client patron bond. They focus more on the subsistence capture fisheries. Nurdin and Grydehøj (2015) add that the consequences of commercial fishing behaviour are the decreasing fish stocks and unwanted ecological impact due to the encouragement of high levels of exploitation.

The following table presents the results of the standardization and calculation of the livelihood vulnerability index (LVI) of 60 respondents (Table 2). Vulnerability is the level of a livelihood system experiencing losses due to the exposure to hazards, disturbances and pressures (Berkes, 2007). Table 2 shows the results of LVI input for all components (main components and subcomponents). The LVI value for Spermonde fishers is 0.56 which indicates that they are highly vulnerable to the exposure/stress such as the changing climate which includes extreme weather, strong winds and high waves (1.00), the limited access to formal financial services or institutions such as banks or cooperatives (1.00), the further location of the Fishing Ground (0.97), as well as food sensitivity (1.00). The adaptive capacity in the form of socio-demographic profile (0.59) and livelihood strategy (0.48) are also high. Meanwhile, a social network is at the level of 0.44.

Table 2. Index of sub-component, main component and total LVI

| Components | Subcomponent | Sub-component value | Main Component | Main Component Value | Category |
|---|---|---------------------|--|----------------------|-------------------|
| Adaptive capacity | Percentage | | | | |
| | Heads of fisher families, age >40 years old | 0.67 | Socio-Demography | 0.59 | Highly vulnerable |
| | Heads of fisher families, not passing junior high school (9 years program of study) | 0.51 | | | |
| | Number of family members >4 | 0.59 | | | |
| | Percentage | | | | |
| | Heads of fisher families with side occupation in the non-farm sector | 0.00 | Livelihood Strategies | 0.34 | Vulnerable |
| | Heads of fisher families with fishing as the main occupation | 1.00 | | | |
| | Heads of fisher families with gold/jewelry possessions | 0.02 | | | |
| | Percentage | | | | |
| | Heads of fisher families have debts to <i>punggawa</i> (middlemen) | 0.89 | Social networks | 0.48 | Highly vulnerable |
| | Heads of fisher families have access to a formal financial institution | 0.00 | | | |
| Sensitivity | Percentage | | | | |
| | Heads of fisher families with dependency on the catching results | 1.00 | Food | 1.00 | Highly vulnerable |
| | Heads of fisher families sell the catch to f the daily needs | 1.00 | | | |
| | Percentage | | | | |
| | Heads of fisher families have access to a clean water source | 0.64 | Water | 0.32 | Vulnerable |
| | Heads of fisher families with experience of problems of water availability | 0.00 | | | |
| | Percentage | | | | |
| | Access difficulty to public health | 0.00 | Health | 0.48 | Highly vulnerable |
| | Heads of fisher families having social-health insurance from the government | 0.95 | | | |
| | Exposure/stress | Percentage | | | |
| Heads of fisher families with difficulties during extreme weather of strong winds and high waves. | | 1.00 | Social, economic and ecological stress | 0.61 | Highly vulnerable |
| Heads of fisher families with farther fishing ground | | 0.97 | | | |
| Heads of fisher families with difficulties due to not being provided with the place of the fish auction | | 0.93 | | | |
| Heads of fisher families with difficulties from not having cold storage/ice availability | | 0.21 | | | |
| Heads of fisher families with difficulties in operational capital | | 0.46 | | | |
| Heads of fisher families with difficulties to market their fishing catch | | 0.34 | | | |
| Conflicts between fishers | | 0.00 | | | |
| Heads of fisher families with difficulties in accessing the formal financial institution | | 1.00 | | | |
| | LVI value of Spermonde Fishers | | | 0.56 | Highly vulnerable |

The value of exposure is considered high because Spermonde fisher households strongly depend on the sea for its catch. During extreme weather and high waves or due to the increasing number of fishers and fewer fish stocks are available in nature. Even though the fishers in this selected study site live closely to the main island and capital city of South Sulawesi Province, they only rely on fishery resources as their livelihood resources. This may result in a highly vulnerable livelihood. Fishers being dependence on the sea is evidenced by their average time spent for sailing in addition that they have no other side occupations besides fishing. Quoting Béné and Friend (2011), " *they are not poor because they are, but they are unable to diversify their livelihood hence they are vulnerable to any stresses and shocks of their activities*". The vulnerability value of sensitivity of food, water and health is also high due to the fishers being highly dependent on water, that they even must buy it (reducing their cash income) from PAM or PDAM as only very few of them have wells.

With the ownership or marketing rights of the catch in the hands of the *punggawa*, it leads the fishers to comply with the price set by the *punggawa* as their form of moral responsibility from borrowing the boat, fishing gear and even capital from the *punggawa*. High vulnerability as the impact of the high value of the exposure component and sensitivity cannot be decreased by the adaptive capacity in the form of livelihood strategies because other sub-components of adaptive capacity, which are the age of the head of the family being more than 40 years old, not passing junior high school (mandatory 9 years of formal study) and having dependence on *punggawa*, as well as their inability to access formal financial institutions, also have a high vulnerability value.

Furthermore, when the calculation of vulnerability level adapted from the IPCC (Intergovernmental of Climate Change) is applied, et al., (2018) stated that LVI-IPCC, which is developed by LVI, is an alternative method that is used as a proxy for the vulnerability value of the livelihoods in a community caused by the climate change. Based on the IPCC (2014), three parameters are required: exposure, sensitivity, and adaptive capacity. Thus, LVI-IPCC is a composite calculation. The vulnerability value is obtained by deducting the exposure value with the adaptive capacity value and multiplying it with the sensitivity value. According to Hahn et al., (2009), the scales of -1 - (-0.4), -0.4 - 0.3 and 0.3 - 1 indicate zero, vulnerable, average/vulnerable and highly vulnerable, respectively. In refer to Shah et al., (2013), vulnerability value that is near -1 and +1 indicates the lowest and highest vulnerability, respectively. See Table 3 for the overall values of LVI-IPCC of the Spermonde fishers being 0.09.

Table 3. Calculation of factors contributing to LVI-IPCC value of Spermonde fishers

| Main components | Subcomponent value | Subcomponent weight | Main Component Value | Category |
|------------------------|--------------------|---------------------|----------------------|-------------------|
| Stress/exposure | 0.61 | 8 | 0.61 | Highly vulnerable |
| Adaptive capacity | 4.08 | 8 | 0.51 | Highly vulnerable |
| a. Socio-demography | 1.43 | 3 | | |
| b. Livelihood strategy | 1.02 | 3 | | |
| c. Social network | 0.89 | 2 | | |
| Sensitivity | 4.62 | 6 | 0.60 | Highly vulnerable |
| a. Food | 2.00 | 2 | | |
| b. Water | 0.67 | 2 | | |
| c. Health | 1.95 | 2 | | |
| LVI-IPCC Index value | | | 0.06 | Vulnerable |

The LVI-IPCC value of Spermonde fishers indicates their livelihoods are at the average level of vulnerability (moderate) to hazard exposure/socioeconomic and ecological changes caused by climate change. The difference between the LVi and LVI-IPCC values is based on the integration of the LVI components. In general, LVI is measured based on the average of each component, while LVI-IPCC for each component is integrated into 3 components (exposure/pressure, adaptive capacity, and sensitivity) before being calculated under the LVI-IPCC formula.

3.3 Adaptation mechanism of the livelihood of the fishers

Adaptation is a behavioural and characteristics adjustment of a system that increases its ability to cope with external stress, or a respond to stressors (Smit & Wandel, 2006). These forces are inseparable and interrelated between each other. An adaptive capacity emerging from the community includes the strong kinship networks that can absorb pressure, the presence of local leaders, communication channels, and the ability to organize itself, as well as the one emerging from a more general economic, social and political system such as subsidy program from the government (Smit & Wandel, 2006).

Adaptation, in principle, is to minimize vulnerability and build resilience. In other words, fishers must have more resilient, strong, and flexible conditions upon the impacts arising from the pressures on their livelihoods. Adaptation mechanisms are required to reduce vulnerability and increase resilience. It is required for all fisher households to carry out strategies to maintain their livelihoods. However, only those who have the capital and wide access succeed. Such adaptation mechanism established by the households depends on the conditions of the five livelihood capitals they have. They develop livelihood resilience by using a set of social, economic and ecological adaptation mechanisms based on the ecosystem of an area (Dharmawan *et al.*, 2016). Based on the five livelihood capitals that are owned and accessible by the Spermonde fishers, three types of adaptations are established as the followings:

3.3.1 Ecological Adaptation

Ecological adaptation is carried out by utilizing natural capital such as the sea and existing resources as the alternative source of livelihood. Most of the ecological adaptations have been carried out by Spermonde fishers which are resulted from the fisher's limited human resource quality. As previously explained, most of the fishers have no other skills and occupations apart from fishing. The followings are some of the strategies applied by the Spermonde fishers (Figure 5).

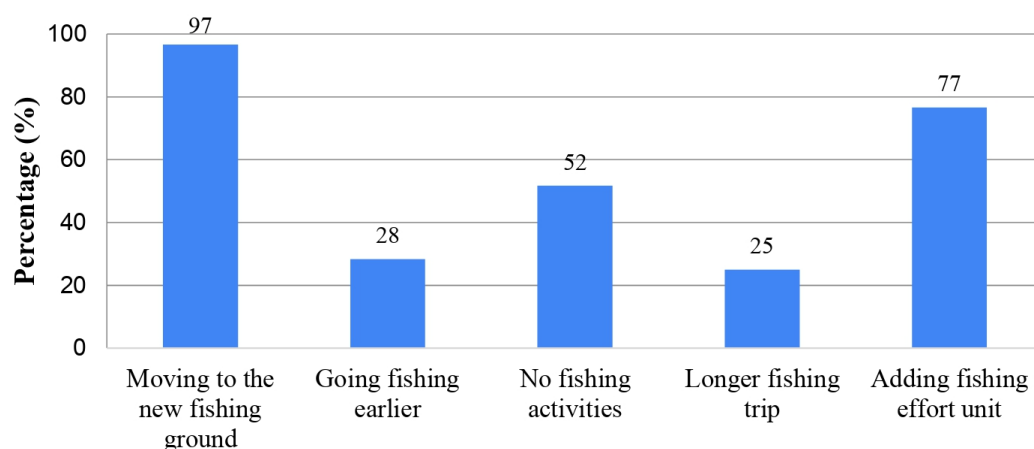


Fig 5. The ecological mechanism carried out by Spermonde fishers

Based on the strategies selected by the Spermonde fishers, sailing regardless of the conditions is the most chosen, indicating that their livelihood strategy is intensification, that although fishing activities require a long time and uncertain results, the activity is still done whatsoever. Fishers consider fishing to secure their family life by providing daily food and income. Based on this reason, they continue to sail although they experience decreasing and fluctuating number of fish caught. Different livelihood strategies are influenced by various factors including environmental conditions as well as cultural, social and political backgrounds. Hence, the rationale behind selecting an adaptation strategy and its impact may be different on each ownership location of capital, income, opportunities and social relations (Ellis, 1998). Most fishing communities in Ghana have quite small capital such as land, and consequently, they tend to search for other livelihood opportunities as labourers and micro-business persons (Gordon *et al.*, 2010). Meanwhile, the human resources of Spermonde fishers are considered low due to also such low education, limited skills, and lack of mobility that consequently, they have to continue fishing to survive.

Panayotou (1982) in Yuerlita dan Perret (2010) state that small-scale fishers who are constrained by the lack of geographic mobility and access to alternative occupational activities potentially, will increase their level of fishing effort. Poor households have less diversified income due to their lack of capital, leaving them with fewer opportunities for other livelihood options (Abdulai & CroleRees, 2001). Adding more fishing gears is an ecological adaptation mechanism for activating their physical capital. It is expected that the increasing number of fishing gear will obtain more or optimal fishing results. However, on the other hand, this will certainly bring an impact on the availability of fish stocks in nature when accompanied by their increasingly intense fishing.

3.3.2 Economic adaptation

Strategies taken to optimize the economy or replace the lost sources of income include the utilization of the financial capital or by activating other livelihood capitals, such as selling their savings of gold and valuable items, in addition to gender role to support fisher livelihoods, for example, the wives who also sometimes help by working in shredded-fish processing industrial sector. The following figure is a graph of the selections of economic adaptation mechanisms carried out by Spermonde fishers (see Figure 6).

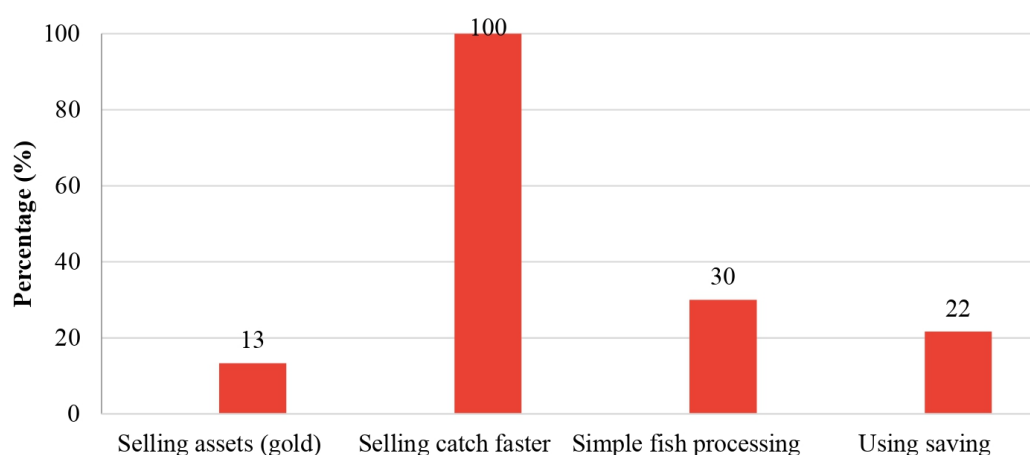


Fig 6. Economic adaptation mechanism of Spermonde fishers

The main economic adaptation mechanism selected by the fishers of Spermonde is to sell their catch as soon as possible on the very day. The reason for such tendency is due to the catch being the most accessible natural capital, that

when the catch is sold immediately, cash to pay for their daily needs will be on hand soon.

The adaptation mechanism carried out by the Spermonde fishers is continued by the wives, by selling their savings of gold jewellery. But this is only within the urgent condition and large needs. The women also contribute to activities related to fish processing such as working in the shredded-fish or fish-balls processing industries. The *cash income* earned by the wives can support the fisher's economy. Under the condition that Spermonde fishers do not have financial capital in financial institutions such as banks, cooperatives or even pawnshops. They only use either their savings obtained from their income from selling the fish or *cash income* from their wives.

3.3.3 Social adaptation

The social adaptation is carried out by utilizing the existing social ties in the community. Social ties among the Spermonde community, one of which is with the *punggawa* who are mostly relatives or neighbouring relationships with the fishers have, where trust between *punggawa*-fishers is highly valued. Due to their adequate financial capital, the *punggawa* in Spermonde Islands have extensive social networks such as connection to the *pattern* on the main island which ensures that the catch is sold. The following is the social adaptation mechanism carried out by the fishers of the Spermonde Islands (Figure 7).

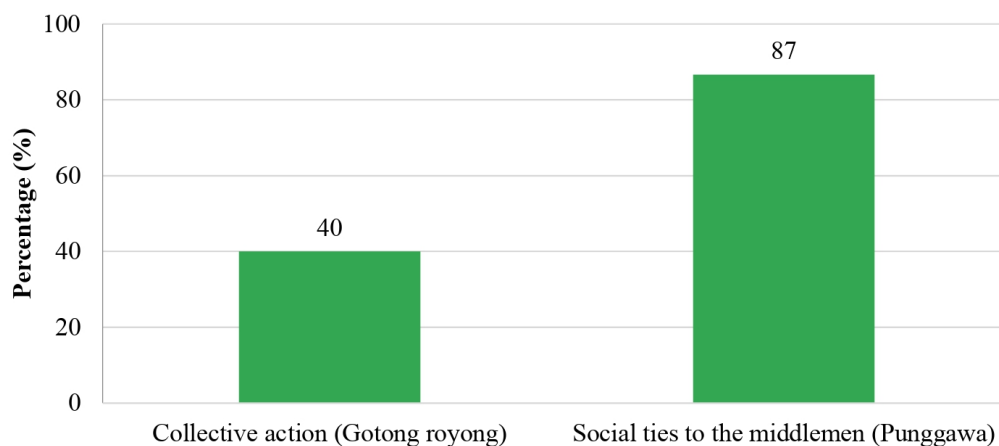


Fig 7. The social adaptation mechanism of Spermonde fishers

The fishers generally use their social ties with *punggawa* to solve problems related to their lack of capital for sailing or to pay for their daily need for food. Therefore, they choose to debt on either the skipper or the *punggawa* under their client-patron relationship. Borrowing from neighbours or relatives is rare because both sides also lack of cash except during the harvest season when the excess cash is used to pay off debts or to buy gold for savings.

Having a loan to the *punggawa*/skipper can be said as a *negative coping* mechanism. On one hand, the relationship between fishers and *punggawa* can be mutually beneficial, but in some cases, an imbalance of profit acquisition may occur. Fishers benefit from borrowing the capital for fishing, while the *punggawa* benefits from buying the catch. The imbalance may occur when the price set by the *punggawa* is lower than in auctions. However, under difficult economic conditions, especially during the scarce season or when the fishers do not sail, the *punggawa* seems to present as the economic safety net for the fishers because the *punggawa* can immediately provide debt of cash for the fishers to pay their daily needs.

As the result, many fishers in Spermonde have no other choice than to sell their catch to the *punggawa*. Their debt to the *punggawa* is a factor of such a bond relationship between them, that the fishers must sell their catch only to the *punggawa*. The payment to *punggawa* also arises due to the uncertainty of the catch and insufficient capital for sailing. Under the debt bond, the *punggawa* obtain two benefits at once: the profit resulting from the purchase price set by themselves and the profit when acting as the intermediary for selling the catch to the *pattern* on the main island, such as the City of Makassar.

The absence of a fish auction system (TPI) in Spermonde makes the small-scale fishers in Spermonde market their catch in three methods: 1) Spermonde fishers - Island *Punggawa* – Paotere *Punggawa* - Industry; 2) Fishers- Paotere *Punggawa* - Industry; 3) Island Fishers - Industry. The following is an illustration of the marketing patterns of Spermonde fishers (Figure 8).

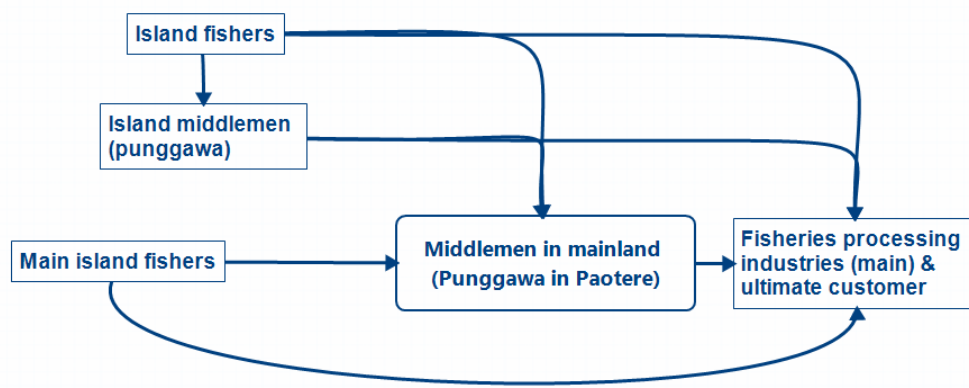


Fig 8. The fish marketing of Spermonde fishers

The first chain pattern is the most practised by the Spermonde fishers due to their bond with the *punggawa* as previously described, as well as their low social network. The limited financial capital also contributes to their inability to break their bond with the *punggawa*. This occurs because the *punggawa* is the only social capital they can act as their economic safety net due to their limited access to formal financial institutions and the absence of a fish auction system.

3.4 Analysis of livelihood strategy of Spermonde fishers

The livelihood strategies carried out by fishers contribute to determining their income. Livelihood strategy is defined as the activity or decision taken by household members to survive and or get better. The decision of survival means developing various strategies for the security and balance of livelihoods of the household (Dharmawan 2007). The livelihood strategy is carried out by utilizing the sources of living they have. Scoones (1998) states that livelihood strategies can be grouped into three types of strategies: 1) intensification; 2) double income pattern; and 3) migration. Dharmawan (2007) states that intensification is fully carried out by people who depend on natural products. Due to limited capital, they will use the intensification system or other more modern activities or else, be more capital intensive. The double income pattern means having more than one occupation. It is a combination of the number of occupations a person has, which consists of the main occupation in the agricultural sector and side occupations in the non-agricultural sector (farm and non-farm). Migration is a permanent movement of the population or residence to other places for a relatively long period of time.

Nissa et al., (2019) state that a livelihood strategy is considered to be implemented when a person/household can activate some of the livelihood capitals they have to accumulate their other livelihood capitals. Based on the characteristics of the adaptation mechanism carried out by the Spermonde fishers, it is identified that intensification is the selected livelihood strategy. This is due to their limited access and activation to the livelihood capital such as formal financial credit (financial capital). Thus, they do not have the basic capital to diversify their business, both fisheries and non-fisheries. The low social capital such as the social networks leads the fisher groups to carry out marketing of their catch with sole dependency on the *punggawa* because they have no other place to sell their catch, which consequently results in less cash income. The followings are some of the livelihood strategies implemented by the Spermonde fishers when facing some of their problems by activating their livelihood capital, as presented in Table 4.

Table 4. Livelihood strategies of the fishers

| Strategies | Category types | Capital category |
|--------------|--|--|
| Spatial | Moving the location of fishing ground, right or left farther | 1. Physical Capital: boats, and fishing gears to optimise the natural capital (the catch results) 2. Human resource capital: sailing power and skill, searching for new fishing grounds |
| Exploitation | Adding more fishing duration per trip | 1. Social Capital: activating the bond with the <i>punggawa</i> to access the financial capital (additional operational capital) |
| Role sharing | Selling their jewellery savings, searching for other additional income | 1. Human resource Capital: fishers' wives working in fish product industries, fishers' children reaching productive age to also work on the sea to optimise the financial capital (<i>cash income</i>) |

Table 4 shows that out of various activities and the utilization of their livelihood capitals, Spermonde fishers depend only on one sector, which is the fisheries sector (pre-post), indicating that intensification is their livelihood strategy.

Recommendations for the government and stakeholders

In strengthening the socioeconomic condition of the fishers' community in Barrang Caddi Island, several actions can be made such as (1) developing the community's economic activities, network and local culture that prioritizes sustainable principles; (2) improving community access facilities to capital; (3) providing human resources training in the field of fishing up to the marketing; as well as (4) providing the fishery extension workers to foster enthusiasm for the fishers to become prosper fishers and to take direct monitoring and evaluation. It is necessary to established a Village Unit Cooperative with simple administrative requirements to enable the fishers to have access to sufficient operational capital for both fishing and marketing activities. Sufficient financial capital can also help them to start diversifying their livelihoods by doing various other businesses in the fishing and/or non-fishery sectors.

To minimize the fisher's dependency to *punggawa* and to optimize the fisher's income through the fish auction prices, it is recommended to build a fish auction system and place. By doing so, the government can also monitor fish landings and support fish stock availability especially because most of the fishers in Spermonde depend on fishing activities for their livelihoods. Furthermore, ecotourism that prioritizes the aspects of nature conservation, empowerment of the socio-cultural economy of local communities and aspects of learning, may be developed considering the white sandy beaches in the Spermonde Islands. It is expected to trigger the fishers to have a double income pattern to minimize their livelihood vulnerabilities and maintain a sustainable fisheries livelihood sector.

Conclusions

Spermonde fishers are small-scale fishers, with the majority sailing by using a boat under 5GT and simple fishing gears, such as fishing rods and nets. The most owned and accessible livelihood capital of Spermonde fishers is the natural capital, while the lowest in the social capital. The livelihood vulnerability level of Spermonde fishers is highly vulnerable (0.56). The adaptation mechanisms carried out by the Spermonde fishers include ecological (changing fishing ground locations, adding more fishing gears), economic (selling the catch as soon as possible and selling gold jewellery savings) and social (utilizing the patron-client social bond with the *punggawa*) mechanisms. With the exposure to danger/pressure or disturbance due to the effects of climate change, and socio-economic and political changes, the livelihood strategy of Spermonde fishers is intensification. This strategy is selected because most fishers are only able to carry out spatial strategies, exploitation and role-sharing with activities that are entirely dependent on natural capital, which is the fish resources. Although resources and catches are likely to decrease, fishing remains the main livelihood.

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Endnotes

1. Patron-client is the basis of social relations for the fishing or coastal community. Patron-client social relations are quite dominant and established due to the characteristics of the livelihood conditions, the economic system, and the environment. These relationships are patterned in the activities of production organizations, marketing, and social leadership. Patron-client relationship patterns can either hinder or support the socio-economic change (Kusnadi 2009).

References

- Abdulai, A., & CroleRees, A., 2001. Determinants of income diversification amongst rural households in Southern Mali. *Food Policy*, 26(4), 437–452. [https://doi.org/10.1016/S0306-9192\(01\)00013-6](https://doi.org/10.1016/S0306-9192(01)00013-6)
- Adger, W.N. and Kelly, P.M., 2001. Social vulnerability and resilience. In: Adger, W.N., Kelly, P.M. and Nguyen Huu Ninh (eds). *Living with Environment Change*. Routledge, London and New York.
- Allison, E. H., & Ellis, F., 2001. The livelihoods approach and management of small-scale fisheries. *Marine Policy*, 25(5), 377-388.
- Béné, C., 2001. When Fishery Rhymes with Poverty: A first step beyond the old paradigm on poverty in small-scale fisheries. *World Development* 31(6): 949-975.
- Béné, C., and Friend, R. M., 2011. Poverty in small-scale fisheries: old issue, new analysis. *Progress in Development Studies*, 11(2), 119–144. <https://doi.org/10.1177/146499341001100203>

- Chambers, R., and Conway, G., 1992. Sustainable rural livelihoods: practical concepts for the 21st Century. IDS Discussion Paper 296. Brighton. 29p.
- DFID (Departement for International Development), 1999. Sustainable livelihoods guidance sheets framework introduction vulnerability transforming. Context, 26. <https://doi.org/10.1002/smj>
- Dharmawan, A. H., 2007. Sistem penghidupan dan nafkah pedesaan. Sodality: Jurnal Sosiologi Pedesaan Jurnal Transdisiplin Sosiologi, Komunikasi, Dan Ekologi Manusia, 1(2), 169–192. <https://doi.org/https://doi.org/10.22500/sodality.v1i2.5932>
- Dharmawan, A. H., Putri, E. I. K., and Mardiyarningsih, D. I., 2016. Smallholder farmers resilience in rural ecological crisis: a case study West Java, Indonesia. International Journal of Sustainability in Economic, 12(3), 17–34.
- Dirjen Perikanan Tangkap, 2000. Buku statistik perikanan Indonesia. Jakarta: Direktorat Jenderal Perikanan.
- Dulvy, N.K., Sadovi, Reynolds J.D., 2003. Extinction vulnerability in marine population, Fish and Fisheries 4: 25-64.
- FAO, 2020. The state of world fisheries and aquaculture 2020. <https://doi.org/10.4060/ca9231en>
- Ellis, F., 1998. Household strategies and rural livelihood diversification. Journal of Development Studies, 35(1), 1–38. <https://doi.org/10.1080/00220389808422553>
- Ellis, F., 2000. Rural livelihood diversity developing countries: evidence policy implications. Overseas Development Institute, (40).
- Gordon, A., Pulis, A., 2010. Livelihood diversification and fishing communities in Ghana's Western Region. WorldFish Center. USAID Integrated Coastal and Fisheries Governance Initiative for the Western Region, Ghana. 69pp.
- Gravitiani, E., Fitriana, S. N., & Suryanto, 2018. Community livelihood vulnerability level in northern and southern coastal area of Java, Indonesia. IOP Conference Series: Earth and Environmental Science, 202(1), 1–9. <https://doi.org/10.1088/1755-1315/202/1/012050>
- Hahn, M. B., Riederer, A. M., & Foster, S. O., 2009. The livelihood vulnerability index: a pragmatic approach to assessing risks from climate variability and change-A case study in Mozambique. Global Environmental Change, 19(1), 74–88. <https://doi.org/10.1016/j.gloenvcha.2008.11.002>
- IPCC, Alonso, F. J. G., Llamazares, A., Riera, V., Vivanco, M., García, S., and Díaz, M. R., 2014. Effect of an n-n chelate ligand on the insertion reactions of carbon monoxide into a manganese-alkyl bond. In Organometallics (Vol. 11). <https://doi.org/10.1021/om00044a023>
- IPCC, 2001. Climate change 2001: impact, adaptation, and vulnerability, Contribution of Working Group II to the Third Assesment Report. Cambridge University Press. Cambridge, UK.
- Miñarro, S., Navarrete, G., Reuter, H., & Putten, I. E. Van, 2016. The role of patron-client relations on the fishing behaviour of artisanal fishermen in the Spermonde Archipelago (Indonesia). Marine Policy, 69, 73–83. <https://doi.org/10.1016/j.marpol.2016.04.006>
- Nissa, Z. N. A., Dharmawan, A. H., & Saharuddin, S., 2019. Vulnerability analysis of small fishers's household livelihoods in Tegal City. Komunitas: International Journal of Indonesian Society and Culture, 11(2). <https://doi.org/10.15294/komunitas.v11i2.18583>
- Nurdin, N., & Grydehøj, A., 2015. Informal governance through patron – client relationships and destructive fishing in Spermonde Archipelago, Indonesia. Journal of Marine and Island Cultures. <https://doi.org/10.1016/j.imic.2014.11.003>
- Ormerod, S.J., 2003. Current issues with fish and fisheries: editor's overview and introduction. Journal of Applied Ecology 40: 204–213.
- Pauly, D., V. Christensen, J. Dalsgaard, R. Froese. F. Tores Jr., 1998. Fishing down marine food webs. Science 279: 860-863.
- Salas, S., Bjørkan, M., Bobadilla, F., & Cabrera, M. A., 2011. Poverty mosaics: realities and prospects in small-scale fisheries. Poverty Mosaics: Realities and Prospects in Small-Scale Fisheries. <https://doi.org/10.1007/978-94-007-1582-0>
- Satria A., 2015. Pengantar sosiologi masyarakat pesisir. Jakarta: Yayasan Pustaka Obor.

- Scoones, I., 1998. Sustainable governance of livelihoods in rural Africa: A place-based response to globalism in Africa. *Development* (Basingstoke), 42(2), 57–63. <https://doi.org/10.1057/palgrave.development.1110037>
- Shah, K. U., Dulal, H. B., Johnson, C., & Baptiste, A., 2013. Understanding livelihood vulnerability to climate change: applying the livelihood vulnerability index in Trinidad and Tobago. *Geoforum*, 47, 125–137. <https://doi.org/10.1016/j.geoforum.2013.04.004>
- Smit, B., & Wandel, J., 2006. Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, 16(3), 282–292. <https://doi.org/10.1016/j.gloenvcha.2006.03.008>
- Somekh, B., & Lewin, C. (Eds.), 2005. *Research methods in the social sciences*. Sage.
- Suadi, & Nakagawa, M., 2008. Resources management failures, fishery depletion and conflicts in Indonesian marine fisheries. *Journal of Rural Economics Special Issue 2008*: 334-340.
- Thorpe, A., C. Reid, R. van Anrooy, C. Brugere, Becker, D., 2005. Asian development and poverty reduction strategies: Integrating fisheries into the development discourse, *Food Policy* 31(5): 385-400.
- Yuerlita, and Perret, S. R., 2010. Livelihood features of small scale fishing communities: a case from Singkarak Lake, West Sumatera, Indonesia. *International Journal of Environment and Rural Development*, 6(1–2), 94–101.