

## Sustainability of Small Scale Capture Fisheries in Banggai Laut Waters, Indonesia

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**ABSTRACT:** Small scale capture fisheries is one of the leading sectors that drive the economy of Banggai Laut Regency. Fishing technology improved related to fishing efforts has an effect on the preservation of fish stocks resource in the area that it required management efforts. This study aims to determine the sustainability status of small scale fisheries in Banggai Laut Regency based on ecological, fishing technology, social and economic dimensions. The research was conducted from September to December 2017 in seven sub-districts in Banggai Laut Regency. In determining the sustainability status of each dimension, the Rapfish (Rapid Appraisal for Fisheries Sustainability) approach is used. Furthermore, in determining the attributes that had an influence on the sustainability performance of small scale capture fisheries, a leverage analysis is carried out. The results showed that the highest sustainability index was the economic dimension of 75.57 (good), the ecological dimension of 59.25 (good), and the lowest was the social dimension of 22.95 (very bad), the dimension of fishing technology was 22.62 (very bad). Remedial measures that must be taken to improve sustainability performance include improving law enforcement facilities and infrastructure at sea and empowering supervisory officers, limiting excessive use of FAD, providing subsidies to small scale fisheries, and regulating fishing areas between local fishermen and Andon fishermen.

**Keywords:** small scale fisheries; sustainability; Banggai Laut

### INTRODUCTION

Fishery resources in Banggai Laut Regency have a great potential to be developed and utilized. The fish resources of Banggai Laut Regency are not only supplied from the Indonesian Fisheries Management Area (FMA) 714, but also from FMA 715 with a total potential fish resource of both 1,063 tons/year. The potential of the fisheries resources includes large pelagic fish resources, small pelagic fish resources, demersal fish resources, shrimp and other crustacean resources, mollusca resources (squid and sea cucumbers), commercial natural seed resources, coral resources, consumption reef fish resources, resources. ornamental reef fish, sea turtle resources, marine mammal resources, and seaweed resources (Agency for Marine and Fisheries Research and Development, 2014).

The total production of fish resources in Banggai Laut Regency until 2016 reached 68,863 tons. This number increased by 14% when compared to the previous year's production volume. The highest production volume is produced by Boka Kepulauan District with a total production of 13,773 tons or 20% of the total production volume of Banggai Laut Regency. The composition of fish species produced in Banggai Laut Regency includes commodities of large pelagic fish, small pelagic fish, demersal fish, reef fish and other fish species (crustaceans and mollusca). The production of small pelagic fish is the largest, which is 60% of the total production, which is dominated by flying fish and mackerel (Statistics Banggai Laut, 2017).

The availability of resources limited for development, exploration, utilization and management of existing resources becomes important and is a priority concern for each region. Banggai Laut Regency is one of the archipelagic areas that has a very wide sea and potential for large fish resources to be the prime mover of natural resource-based regional economic development. Moreover, the status of Banggai Laut Regency is still relatively new, so it is natural that the utilization and management of this resource will continue to increase its productivity in obtaining

regional income and the welfare of its people (Suman *et al.*, 2016).

However, in the utilization and management of fish resources in Banggai Laut Regency, there are many urgent issues that need attention, including: the population growth in coastal areas which is quite rapid and requires fishery resources to meet their daily needs; there are still many destructive and illegal fishery resource exploitation practices; imbalance in the use of resources between regions and between types of resources; as well as incomplete operational regulations; and there is no synergy in the utilization of fishery resources in a single comprehensive policy and planning (Anas *et al.*, 2011; Sari *et al.*, 2015; Kusdiantoro *et al.*, 2019).

By paying attention to the conditions and problems faced, a comprehensive policy strategy in the management and utilization of fisheries resources is needed in order to maintain the sustainability of fishery resources which includes ecological, fishing technology, social and economic dimensions (Adel *et al.*, 2016; Kasim *et al.*, 2017; Prasetyo *et al.*, 2018). Furthermore, the issues and problems of small scale capture fisheries that are obtained are then identified the sustainability factors (Mardyani *et al.*, 2019; Ninef *et al.*, 2019). These aspects of sustainability are used to formulate small-scale fisheries management policies in Banggai Laut Regency which are also expected to become one of the buffer areas in the national fish logistics system.

## MATERIALS AND METHOD

The research was conducted from September to December 2017 in 7 sub-districts in Banggai Laut Regency, namely Banggai, North Banggai, Central Banggai, South Banggai, Labobo, Bangkurung, and Boka Islands Districts (Figure 1).

The data collected is in the form of ecology, fishing technology, social and economic data. The types of data collected are primary data and secondary data, both quantitative and qualitative data. Primary data collection was carried out using survey methods and direct field measurements as well as structured interviews with the help of a questionnaire. Secondary data collection is carried out through literature study by collecting all information related to the study/research objectives, both from scientific articles and the annual report of the Central Bureau of Statistics of Banggai Laut Regency. The attributes and criteria for each dimension showed at Table 1.

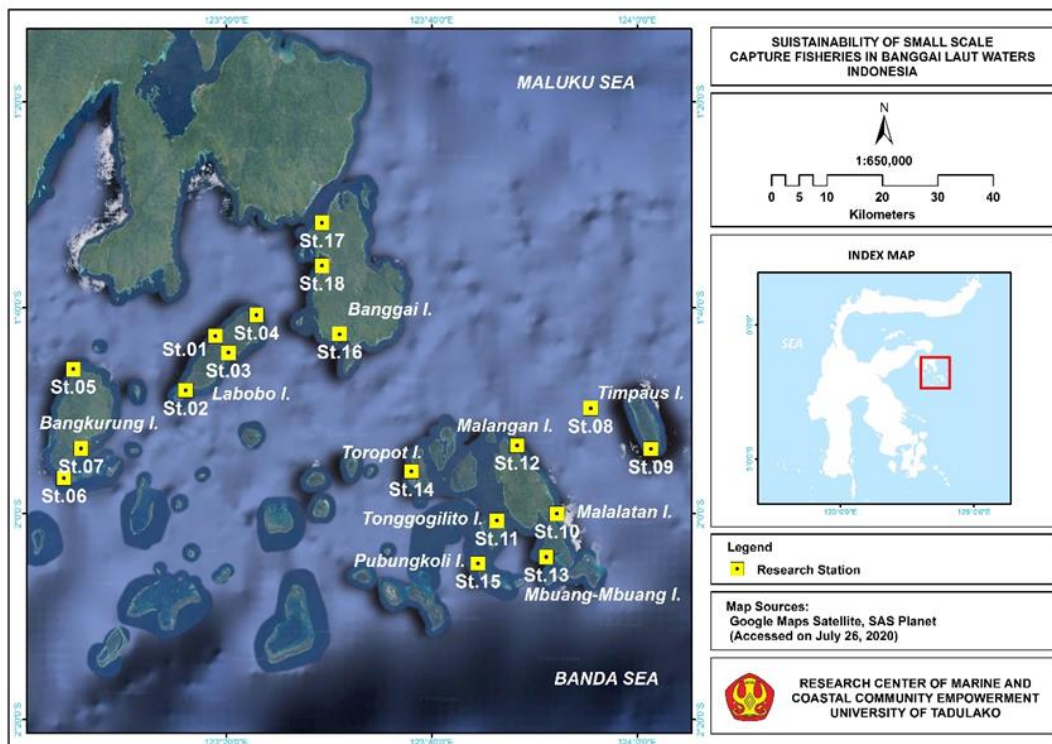


Figure 1. Research location

**Table 1.** Data collection methods

Indicator	Data collection	Criteria
Ecology Dimension		
Exploitation status	Decree of the Minister of Marine Affairs and Fisheries No.50/KepMen-KP/2017	(1) Over exploited; (2) Fully exploited; (3) Moderate
Range collaps	Survey and interview	(1) Fishing ground to be very far, depending on the target species; (2) Fishing ground far, depending on the target species; (3) Fishing ground relatively fixed distance, depending on the target species
Species ETP (Endangered, threatened, and protected species)	Decree of the Minister of Marine Affairs and Fisheries No.49/KepMen-KP/2018	(1) there were ETP individuals caught but not released; (2) there are ETP individuals caught and released; (3) there are no ETP individuals
status of the coral reef ecosystem	line intercept transect method dan visual census	(1) low coverage, < 30%; (2) moderate coverage, > 30% - < 60%; (3) high coverage, > 60%
Status of seagrass ecosystem	transect method and quadratic method	(1) low coverage, < 25%; (2) moderate coverage, > 25% < 50%; (3) high coverage, > 50%
Capture Technology Dimension		
Capture selectivity	Statistics Banggai Laut	(1) Low, >75%; (2) Moderate, 50-75%; (3) High, < 50%
fishing gear modification	Survey and interview	(1) there are modifications; (2) no modification
Fish Attractive device (FAD)	Survey and interview	(1) FAD; (2) There are no tools
destructive fishing	Survey and interview	(1) using tools that are destructive; (2) do not use tools that are destructive
ship size	Statistics Banggai Laut	(1) < 5 GT; (2) 5-20 GT; (3) > 20 GT
fish landing sites	Statistics Banggai Laut	(1) not enough; (2) enough (2-3 TPI); (3) a lot and spread (> 3 TPI)
Social Dimension		
fishery conflict	Survey and interview	(1) >2 type of conflict; (2) 1-2 type of conflict; (3) there is no conflict
environmental knowledge	Survey and interview	(1) Low; (2) Moderate; (3) High
work pattern	Survey and interview, Statistics Banggai Laut	(1) Individual; (2) Family; (3) Group
Economic Dimension		
Fishery contribution to GRDP	Statistics Banggai Laut	(1) Low; (2) Moderate; (3) High
Fishermen exchange rate (FER)	Statistics Banggai Laut	(1)< 100; (2) = 100; (3) >100
subsidy	Survey and interview	(1) none; (2) there is
Alternative livelihoods	Survey and interview	(1) None; (2)there are alternatives

Analysis of the sustainability of small scale capture fisheries in Banggai Laut District using the Rapfish (Rapid Appraisal for Fisheries Sustainability) method developed by the Fisheries Center University of British Columbia (Nurmalina, 2008). The four attributes of sustainability assessment are ecological, fishing technology, economic and social dimensions. Furthermore, in determining the attributes that have an influence on the sustainability performance of small-scale capture fisheries, a sensitivity analysis or leverage analysis is carried out. The most sensitive attribute will contribute to sustainability in the form of changes in Root Mean Square (RMS), namely on the X axis (scale of sustainability) (Hidayanto *et al.*, 2009). The greater the value of the change in RMS, the greater the role of these attributes, the more sensitive it is in shaping the value of sustainability on the sustainability scale.

The sustainability status in this study is classified into four categories of sustainability status. Each attribute has an estimated score, namely a maximum score of 3 for good conditions and 1 for bad conditions and in between for conditions between good and bad. The definitive score is the mode value, which is analyzed to determine the points that reflect the position of the sustainability of the system under study relative to the good and bad points using the MDS statistical ordination technique (Thamrin *et al.*, 2007). The estimated scores for each dimension are expressed in four categories, namely 0-25 which means very bad, 26-50 means bad, 51-75 means good, and 76-100 means very good (Suryana *et al.*, 2012).

## RESULT AND DISCUSSION

The ecological dimension consists of five attributes, namely exploitation status, range collaps, ETP species, coral reef ecosystem status, and seagrass ecosystem status (Rembet *et al.*, 2011; Budiarto *et al.*, 2015; Diah *et al.*, 2018; Airlangga *et al.*, 2018; Sulistyowati *et al.*, 2018; Salmarika *et al.*, 2018). Banggai Laut Regency is included in the Fisheries Management Area (FMA) 714 (Tolo Bay, Banda Sea) and 715 (Maluku Sea). Based on the Decree of the Minister of Marine Affairs and Fisheries No.50/KepMen-KP/2017 regarding the estimated potential, allowable catch, and utilization rate of fish resources in the fisheries management area (FMA) of the Republic of Indonesia, the condition of fish resources in FMA 714, including large pelagic fish, demersal fish, reef fish and lobster, and crabs are designated as fully exploited resources. Meanwhile, the condition of fish resources in FMA 715 such as small pelagic fish, large pelagic fish, and crustaceans have also been fully exploited. Although most of the fish resources in FMA 714 and 715 are classified as fully exploited, there are still some fish resources that are classified as moderate, such as small pelagic fish and panaeid shrimp in FMA 714 and demersal fish and reef fish in FMA 715. This shows that the availability of resources is still quite potential, although it still needs to be properly regulated because the dominant fishing locations are concentrated in coral reef areas which are feared to have the potential to damage the coral reef ecosystem.

The dominant ETP species caught in the waters of Banggai Laut Regency are the proud banggai cardinalfish (*Pterapogon kauderni*). This fish is an endemic fish that is threatened by its sustainability (Makatipu, 2007; Ndobe *et al.*, 2013; Rahman & Safir, 2018). To ensure the existence and availability of these fish populations, the government issued Decree of the Minister of Marine Affairs and Fisheries No.49/KepMen-KP/2018 concerning the determination of the limited protection status of the proud cardinalfish fish. With a limited protection status, fishermen are prohibited from catching the proud dragonfly fish in February, March, October and November because it is the peak of the spawning season. According to field observations, until now fishermen have complied with these rules by not catching in the spawning season.

In general, smallscale fishermen in Banggai Laut Regency do shifting fishing on coral reefs scattered along the coast. The distance between the fishing base and fishing ground varies, the closest one is only 10 minutes by sea, but some is 4 hours by sea. The fishing areas that are most intensely used by fishermen are the Tolungan and Pedal coral reefs. The results of field tracing show that 60% of fishermen have felt the fishing area in the past 5 years and the other 40% think that the fishing location has changed in a direction that is further away from their residential location.

The area of coral reef ecosystem cover in Banggai Laut Regency generally ranges from 39.36-60.14% (moderate cover). There are coral reefs ranging from a depth of 0.5 meters to a depth of 30 meters where in some locations coral reefs will be exposed to the surface of the water when the sea

water experiences the lowest receding. The coral reef area in the study location is the fishing ground for local fishermen and Andon fishermen. Although the status of coral reefs is still sustainable, basically there has been damage to coral reefs due to fish bombs, which is indicated by the discovery of several damaged locations with the type of damage in the form of fine/small fractures <10 cm in size at several points in the study location with an average radius. average between 3–10 meters.

Seagrass ecosystem data collection in Banggai Laut Regency was carried out in 11 observation locations. The data collection locations are in Bone Baru, Lokotoi, Togongpotil, Tinakin Laut, Monsongan, Pulau Reasons, Tolobundu, Labobo, Kongan, Tongo and Mbuang-Mbuang. In general, the condition of the seagrass ecosystem in the 11 locations was still relatively good and very dense and included in the rich category with cover ranging from 45-70%. Seagrass ecosystems with unhealthy conditions are found in the Togongpotil Village and Tinakin Laut Village areas. Meanwhile, seagrass ecosystems with healthy conditions are in the Bone Baru, Lokotoi, Monsongan, Pulau Reasons, Tolobundu, Labobo, Kongan, Tongo and Mbuang-Mbuang areas. Five species of seagrass were found, namely *Enhalus acoroides*, *Halophila ovalis*, *Syringodiun isoetifolium*, *Thalassia hemprichii* and *Cymodocea rotundata*.

The results of the Rapfish analysis of the ecological dimensions showed a sustainability index of 59.25 or in the good category (Figure 2a). Based on the leverage analysis, there are two attributes that are sensitive to the sustainability of the ecological dimension, namely the status of the coral reef ecosystem (Figure 2b).

The fishing technology dimension consists of five attributes, namely modification of fishing gear, fish attractive devices, destructive fishing, size of the ship, and fish landing sites (Nababan *et al.*, 2007; Mamuaya, 2008; Suryana *et al.*, 2012; Damanik *et al.*, 2016). Modification of fishing gear and fishing aids is defined as the use of fishing gear and tools that are not in accordance with the regulations which can have a negative impact on fish resources. The results of interviews conducted with fishermen in Banggai Laut District indicated that 70% of respondents did not modify their fishing gear. The fishing gear used is the one that has been used for a long time and is still considered effective and productive enough to be used today. Meanwhile, 30% of respondents are those who modify fishing gear because of the transfer of information from andon fishermen who are considered to be more effective in increasing catch.

There are two types of fishing aids that are widely used by fishermen in Banggai Laut Regency, namely FADs and light aids. FADs are the dominant fishing tool used, namely as many as 65% of the total respondents, while the other 35% admit to using lights as a fishing aid. Excessive use of FADs with a very close distance will certainly disrupt the habitats or fish migration patterns, so that the life cycle of fish resources will be blocked or cut, which in turn causes fish

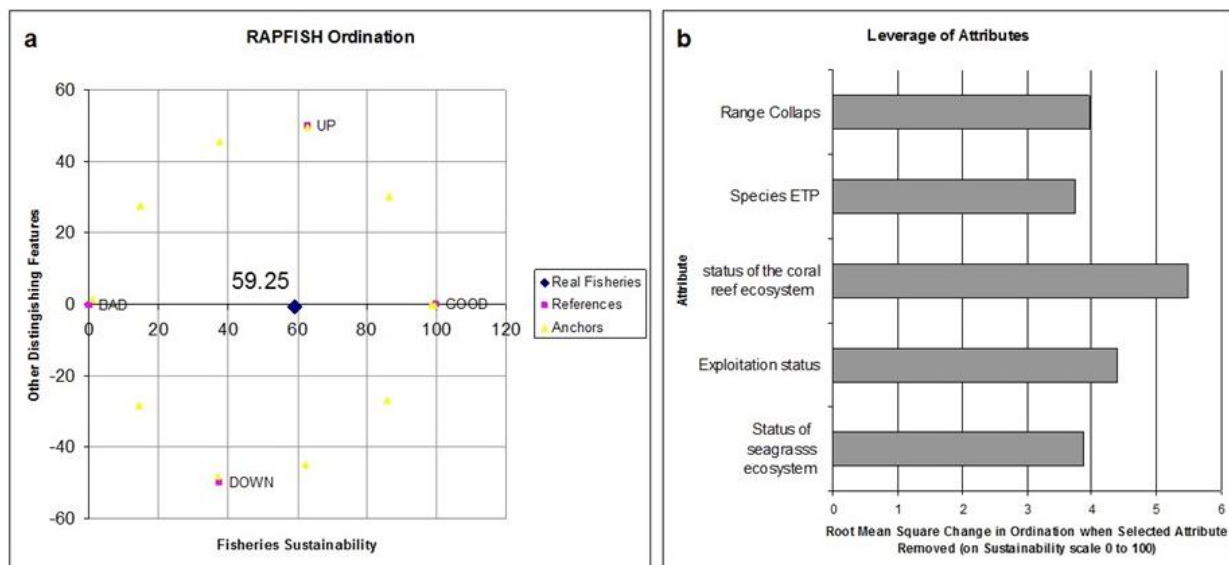


Figure 2. a. Sustainability status, b. leverage analysis on ecological dimensions

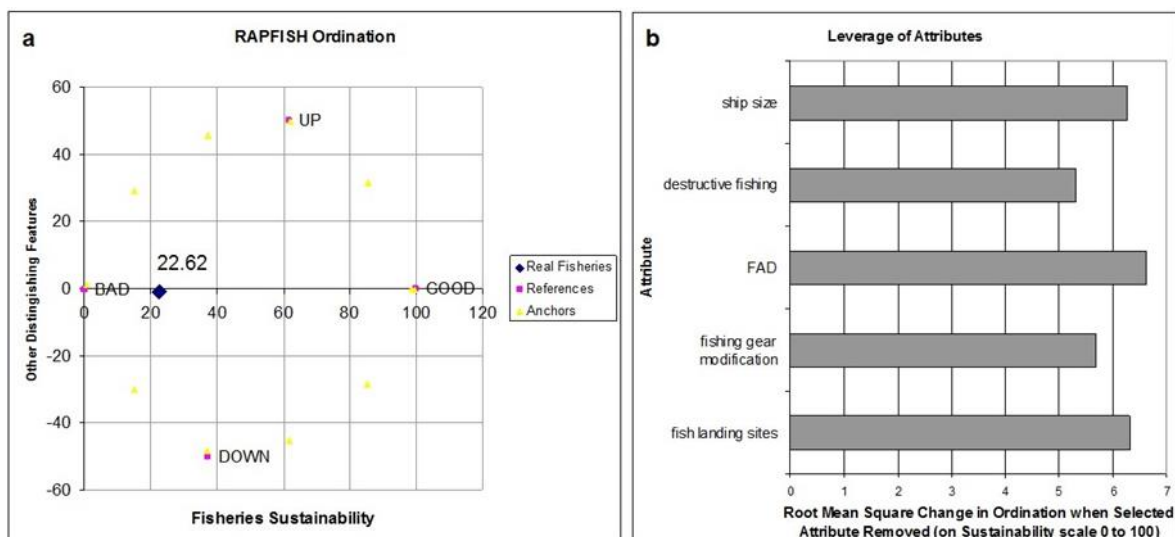
resources to be depleted (depletion) and may even be depleted or extinct. The lack of knowledge and consumer awareness regarding the size that is suitable for trading or consumption, makes its development more difficult to control, so this of course will hamper the realization of a sustainable management of fish resources.

Destructive fishing methods that are rife in Banggai Laut Regency are the use of bombs and fish anesthetics. Even though it is not recorded in fisheries statistics, the use of destructive fishing tools needs to get more attention through strict supervision and law enforcement for destructive fishing actors. Destructive and/or illegal fishing is the biggest threat to the preservation of coastal and marine ecosystems in Banggai Laut Regency, especially coral reef ecosystems. The impact of these destructive and/or illegal fishing practices is now beginning to be felt by the fishing community, especially reef fishermen, who are increasingly difficult to get fish catches. Until now, there are still quite a lot of violations of destructive and / or illegal fishing activities in the sea waters of Banggai Laut Regency. This was proven by identifying the condition of coral reefs which showed rubles in several locations such as Bangkurung Island and Bokan Islands.

Statistics of Banggai Laut Regency show that 54% of the fleets operating in Banggai Laut Regency waters are vessels with a capacity of 5 GT. The large-scale fishing fleets that are seen operating in the waters of Banggai Laut Regency and anchored in the Tinakin Laut area or in Banggai Bay are andon fishermen from other regencies or provinces such as South Sulawesi, Southeast Sulawesi, North Sulawesi, Gorontalo and Bali. The low coverage of the local fleet which is exacerbated by the presence of andon fishermen operating in the waters of Banggai Laut Regency has the potential to cause over-exploitation in the coastal waters of Banggai Laut Regency.

Banggai Laut Regency has two fishing ports (PPI), namely: PPI Tinakin Laut and PPI Mato, Tinakin Darat. PPI / TPI in Banggai Laut District do not have adequate functional facilities, if any, almost all of the facilities are inactive. This fact is the cause of the non-development of a network of facilities between fisheries centers, which should have been driven by the two PPIs managed by the Banggai Laut Regency Fisheries Service. In addition, the inactivity of PPI/TPI is caused by weak management and human resources.

The results of the Rapfish analysis of the fishing technology dimension produced a sustainability index of 22.62 which indicates that fishing technology has a very bad sustainability category (Figure 3a). Based on the leverage analysis, a sensitive attribute that needs to be considered is the use of fish attractive devices (Figure 3b).



**Figure 3.** a. Sustainability status, b. leverage analysis of fishing technology dimensions

The economic dimension consists of three attributes, namely fishery conflicts, environmental knowledge and work patterns (Nababan *et al.*, 2007; Mamuaya, 2008; Suryana *et al.*, 2012). The most prominent fishermen conflict is related to the use of fish resources by andon fishermen from outside the Banggai Laut Regency area. Fishermen in Banggai Laut Regency think that destructive fishing actors still have more rights to exploit existing fish resources even through destructive methods compared to andon fishermen who come from outside the Regency area. As many as 50% of respondents said that andon fishermen need to put in order. This in a short timeframe may not cause a problem considering that Banggai Laut Regency is still not optimal in terms of productivity. However, in the long term this can lead to prolonged conflict if not regulated as soon as possible.

A social problem that is no less important in small-scale capture fisheries in Banggai Laut Regency is the quality of knowledge of fishermen, the majority of which is still not good. This is due to the low level of formal education, which is largely due to the difficulty of schools or access in coastal areas and small islands in Banggai Laut Regency. This lack of education has an impact on the difficulty of fishing communities to accept knowledge transfer and technology transfer, so that violations often occur.

The work pattern of fishermen in Banggai Laut Regency is formed by a family system, especially in fishing activities. In general, a fishing fleet consists of one fishery household. Commodities produced by this fishery household activity include all types of fish, crustaceans, molluscs, seaweed, and other biota obtained from the sea. Of the seven sub-districts owned by Banggai Laut Regency, Bokan Kepulauan District is the region with the highest number of fishery households, namely 1,237 household heads. Meanwhile, the lowest is Banggai Tengah Subdistrict with 130 fishery households.

The results of the Rapfish analysis on the social dimension resulted in a sustainability index value of 22.95 percent which indicates that the sustainability of the social dimension is classified as very bad (Figure 4a). The results of the sensitivity analysis of the three attributes, there is one attribute that is most sensitive to the value of the sustainability of the social dimension, namely fishery conflict (Figure 4b).

The economic dimension consists of four attributes, namely the contribution of fisheries to GRDP, fishermen exchange rates, subsidy levels, and alternative livelihoods (Nababan *et al.*, 2007; Puspasari *et al.*, 2014; Gazali *et al.*, 2017; Jaya & Zulbainarni, 2015). The economic structure of most of the people of Banggai Laut Regency is still dominated by the agriculture, forestry and fisheries sectors which contributed 60.21% to the GRDP of Banggai Laut Regency in 2016. If we examine more deeply, the export base in Banggai Laut Regency is from the plantation sub-sector and fishery. The contribution of the fisheries sub-sector to the agricultural sector in Banggai Laut Regency is felt to be quite dominant, reaching 68,863 tons which includes all activities of marine fishing, hatchery, cultivation and processing of fishery products. Overall, the

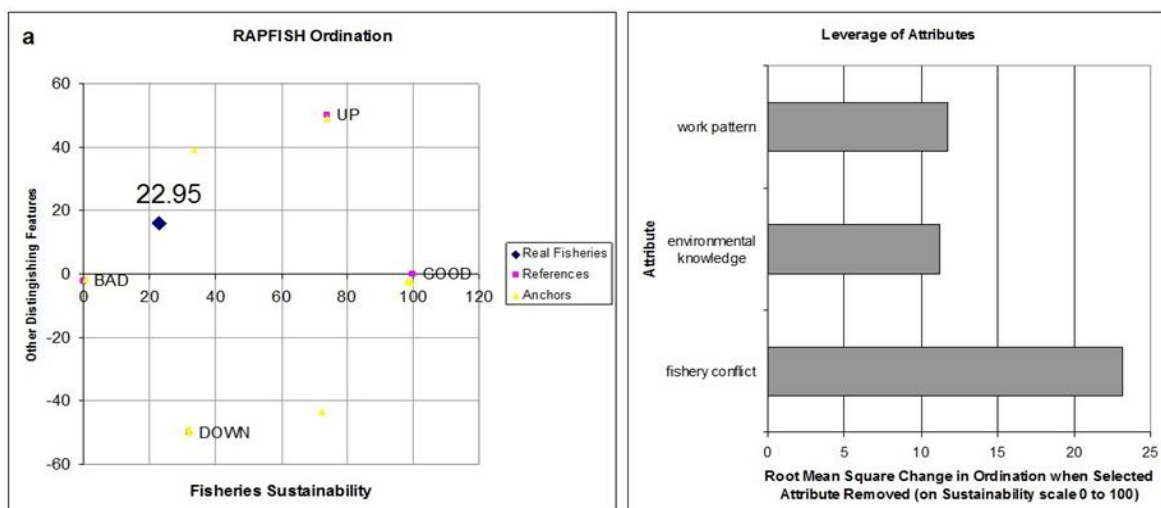


Figure 4. a. Sustainability status, b. social dimension leverage analysis

fisheries sub-sector has a significant role in the total GRDP of Banggai Laut district, so it can be said that the GRDP from the fisheries sub-sector is quite large. However, the problem is because the supply (supply) of fresh fish in Banggai Laut Regency exceeds demand so that the price of this commodity is low and has an impact on the level of fishermen's welfare. Therefore, it is necessary to develop a model to support the fish logistics system in Banggai Laut Regency in order to ensure stable supply and demand.

Based on the results of the study conducted to determine the level of fishermen's welfare by analyzing the exchange rate of fishermen, it is found that in general fishermen in Banggai Laut Regency are still in the welfare category because there are no fishermen with fishermen exchange rates <100. The dominant fisherman household is in Banggai Laut Regency (85%) have fishermen exchange rates > 100 and the other 15% are fishermen with fishermen exchange rates=100. The positive thing that accelerates the Exchange Rate of Fishermen in Banggai Laut Regency is the characteristics of the islands that allow for plantation and livestock activities so that the dominant fishermen have alternative livelihoods apart from being fishermen.

In the Banggai Laut Regency, the ownership status of the fishing facilities is all owned by local owners. In addition, 89% of fishermen in Banggai Laut Regency are able to afford the production facilities and infrastructure independently and are purchased in cash without going through credit to existing regional financial institutions. However, 8% of respondents also obtained some of the production facilities from subsidies and 3% of respondents admitted to obtaining loan capital from local microfinance institutions.

In general, when viewed from the variable household income of fishermen, it shows that all capture fisheries activities, both prototypes of fishing rods, nets and traps, show positive results and are still profitable. The economic factor which is still positive and profitable is what causes the owners of the fishing fleet to survive today. However, if it is examined more deeply, the positive income of fishermen is caused by the existence of alternative livelihoods besides fishing. Alternative livelihoods (non-fishing businesses) that are widely developed are plantations with the main commodities of palawija and horticulture as well as commercial businesses. The results of the Rapfish analysis on the economic dimension resulted in a sustainability index value of 75.57 indicating a good category of sustainability (Figure 5a). The results of the sensitivity analysis show that the attribute most sensitive to the sustainability of the economic dimension is subsidies (Figure 5b).

Based on the sustainability values of each dimension of small-scale capture fisheries management, the highest sustainability index is the economic dimension of 75.57 (good), the ecological dimension is 59.25 (good), and the lowest is the social dimension of 22.95 (very bad), the dimension of fishing technology is 22.62 (very bad) (Figure 6).

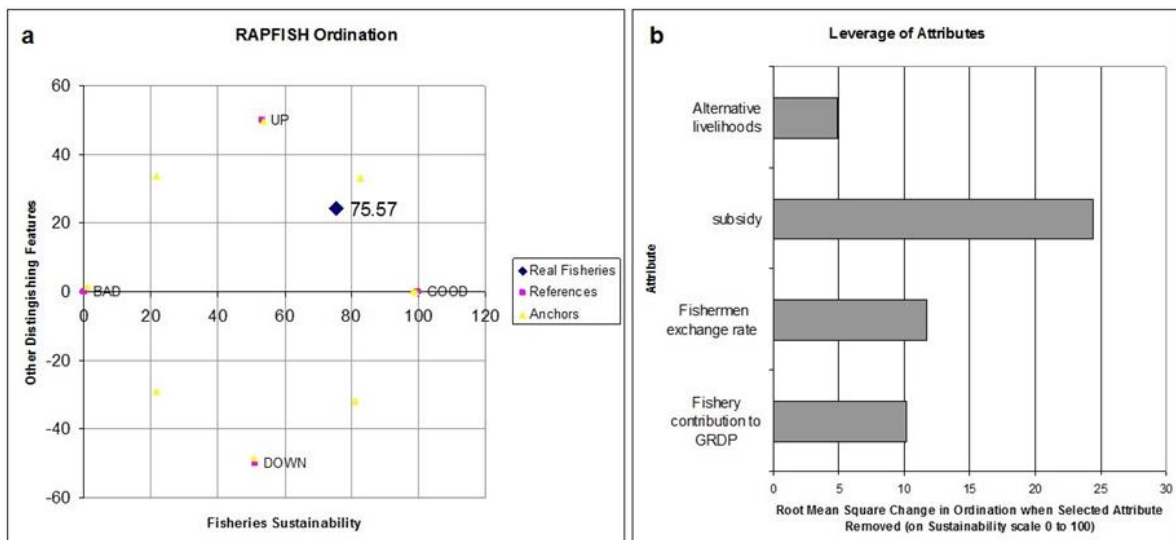
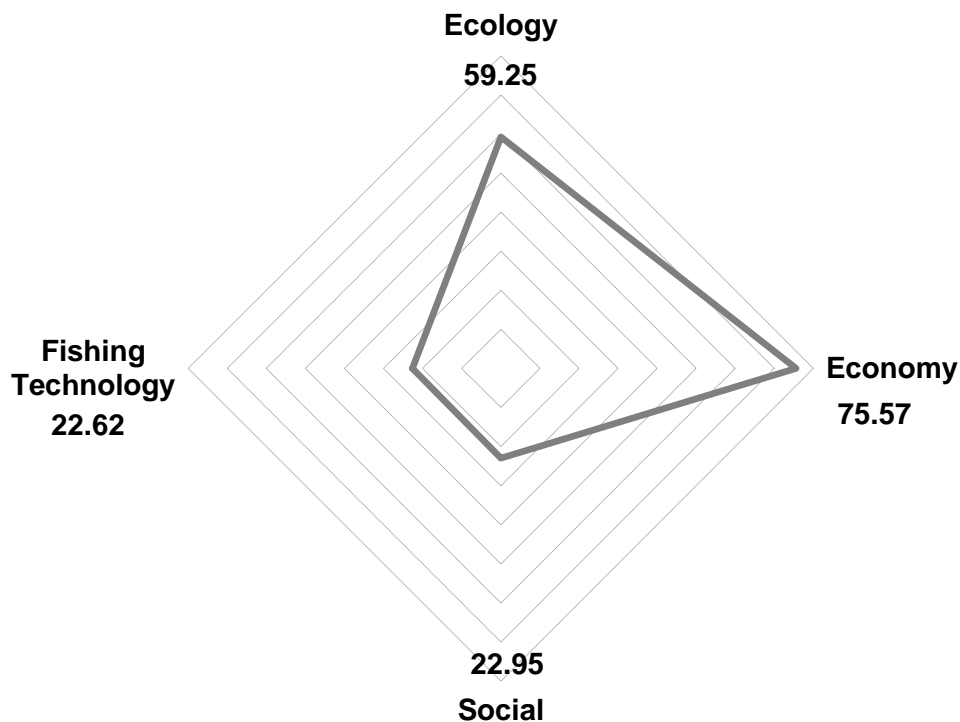


Figure 5. a. Sustainability status, b. leverage analysis on economic dimensions





**Figure 6.** Kite diagram of the sustainability value of each dimension

Small-scale capture fisheries in Banggai Laut Regency are expected to become one of the buffer subsectors in the national fish logistics system, however in practice it has not been able to escape from the complexities of the problems faced, so it needs good management efforts (Sulistyowati *et al.*, 2018; Kusdiantoro *et al.*, 2019; Yonvitner *et al.*, 2020) by conducting an earlier assessment of sustainability performance in order to identify all of existing problems (Damanik *et al.*, 2016; Salmarika *et al.*, 2018; Airlangga *et al.*, 2018). Performance assessment of small-scale capture fisheries must consider all aspects of the ecosystem in a balanced and comprehensive manner (Kasim *et al.*, 2017; Diah *et al.*, 2018; Ninef *et al.*, 2019).

The results of the assessment on the sustainability performance of small-scale capture fisheries in Banggai Laut Regency show two dimensions of sustainability and two dimensions of unsustainability. Even though the two dimensions are considered good, interventions must still be made to maintain the sustainability of small-scale capture fisheries in Banggai Laut Regency, especially in the fishing technology and social dimensions. In order to improve sustainability performance, intervention must be carried out on the four most sensitive attributes, namely the status of the coral reef ecosystem, the use of fishing tools in the form of FADs, subsidies, and fisheries conflicts.

Strategies to improve the sustainability performance of small-scale capture fisheries in Banggai Laut Regency can be pursued by (1) improving law enforcement facilities and infrastructure at sea and empowering fish resource supervisors and fishing boat supervisors optimally in controlling fishermen who use bombs and anesthesia in fishing activities. Controlling fishermen who use bombs and anesthetics can prevent widespread damage to coral reef ecosystems due to fish bombs; (2) limiting excessive use of FADs to a very close distance. An in-depth study is needed in determining the number of FADs that are allowed to operate so as not to disrupt the fish life cycle; (3) It is necessary to provide subsidies to small-scale fishermen in the form of fishing gear and fishing vessels, and it is necessary to distribute it evenly. Apart from equipment assistance, there is also full support from financial institutions and banks for the development of capture fisheries businesses in Banggai Laut Regency; and (4) it is necessary to regulate fishing areas between local fishermen and Andon fishermen to prevent conflicts over utilization and in the end it will erode local fishermen.

## CONCLUSION

The sustainability status of small-scale capture fisheries in Banggai Laut Regency in the ecological and economic dimensions is still considered sustainable, but in the fishing technology and social dimensions it is classified as unsustainable. Corrective measures that must be taken to improve sustainability performance are (1) improving facilities and infrastructure for law enforcement at sea and empowering supervisory officers, (2) limiting excessive use of FADs, (3) providing subsidies to small-scale fishermen, and (4) regulation fishing area between local fishermen and Andon fishermen. The result of this research is expected to be a fundamental consideration for the regional government in preparing a small scale fishery management plan in Banggai Laut Regency.

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