Evaluating Fisheries Livelihoods: Socio-Economic Dimensions and Management Challenges

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ABSTRACT

Fisheries management, which focuses on using fisheries resources to improve the livelihood of the fishing communities, has led to over-exploitation of fish resources on the east coast of North Sumatra. This has led to a decline in the potential of some fish species, which in turn has affected fishermen's incomes. This study aims to identify the socio-economic conditions of fishermen through the Ecosystem Approach to Fisheries Management (EAFM) and the factors that influence them. The data used are primary and secondary data, collected through observation, interviews, and literature studies. The study involved a sample of 64 fishermen from three locations along the eastern coast of Sumatra: Medan, Serdang Bedagai, and Deli Serdang. This research uses a descriptive qualitative method and the EAFM approach to analyze the social and economic conditions of fishermen in Medan, Deli Serdang, and Serdang Bedagai. The results of this study indicate that there has been a decline in the number of fishermen and the capture fisheries production at the research sites. The score of the social domain scored 55.55 (moderate), while the economic domain scored 66.67 (good) indicating effective but improvable management. The research results show that the indicators of stakeholder participation, utilization of local knowledge for fisheries management, asset ownership, and demand for fishery products are in the good category, while the indicators of fisheries conflicts and fishermen's household income are in the poor category, which needed to be the focus for improvement and enhancement.

Keywords: Social and economic, Fishermen, Ecosystem Approach

1. Introduction

Fishermen are defined as individuals who earn a living from marine resources, either by catching fish or other marine animals in the waters, both at the seabed and on the surface, as their primary daily occupation. Interactions between fishermen's households create a social environment where they influence and support each other in fishing activities and daily life (Syahrina et al., 2022). Several studies on fishing communities in Indonesia (Retnowati, 2011; Prihandoko, 2012; Negara et al., 2020; Badarudin et al., 2021) identify them as marginalized groups who are disadvantaged in terms of economic, social, and political aspects. This puts fishermen in a vulnerable position with limited access to or influence over societal life. Traditional fishermen and small-scale fishermen share similarities, with the main difference being that small-scale fishermen use modern equipment and motorized boats, allowing them to fish in wider or more distant areas. Both traditional and small-scale fishermen generally fall into the poor and marginalized category and require attention. They often face low economic conditions, monotonous work, and physical demands.

Small or traditional fishermen typically have low levels of education, limited access to knowledge, technology, and information, limited capital, and use simple tools, which affects their management capabilities and the scale of their operations, making them vulnerable to conflicts and poverty (Pramana, 2017; Mujaddid and Nugroho, 2021; Equanti and Bayuardi, 2018). This situation is exacerbated by the deteriorating environmental quality due to industrial waste pollution and the depletion of fish resources due to overfishing, which impacts the fishermen's income (Panrenrengi et al., 2020; Retnowati, 2011). Fisheries management, which emphasizes the utilization of fishery resources to improve the welfare of fishing communities, has led to the over-exploitation of fish resources (Budiarto et al., 2015; Damanik et al., 2016). Ironically, the condition of fishery resources and ecosystems affects the economic conditions and income of fishermen in the long term, which in turn affects their welfare, education level, skills, and technology ownership (Negara et al., 2020; Sarjulis, 2011; Latuconsina et al., 2024).

Overfishing of certain fish species is a problem across nearly all fisheries management areas in Indonesia, including the East Coast of North Sumatra (Ministry of Marine Affairs and Fisheries, 2022). This is partly caused by the use of inappropriate fishing gear, lack of knowledge about applicable regulations, fishing area restrictions, and insufficient socialization of fishing regulations to fishermen. To maintain the sustainability of marine and fishery resources, effective and sustainable fisheries management is necessary, involving three interrelated components: fishery resources and their ecosystems (natural system), the utilization of fishery resources for the socio-economic well-being of the community (human system), and the governance and policies regulating fisheries management (fisheries governance/management system) (Charles, 2023). This approach is known as Ecosystem Approach to Fisheries Management (EAFM), which aims to provide optimal socio-economic benefits to communities without neglecting the dynamics of ecosystems that are the habitat for these fishery resources (Adrianto et al., 2014).

The Ecosystem Approach to Fisheries Management (EAFM) has six domains or indicator aspects that serve as tools for monitoring and evaluating the implementation of ecosystem-based management principles (Adrianto et al., 2014; Budianto et al., 2015). These six domains include: 1) fish resources; 2) habitat and ecosystems; 3) fishing techniques; 4) economics; 5) social aspects; and 6) institutions. Previous studies on ecosystem-based fisheries management assessments have been conducted in several fisheries management areas and for various fish species, such as in the Anambas Islands (Pregiwati et al., 2015), the blue crab commodity in the Java Sea (Budiarto et al., 2015), the East Coast of North Sumatra (Damanik et al., 2016), octopus in Banggai Laut District (Tarigan et al., 2020), and squid in the waters of Medan City (Harahap et al., 2023). However, no research has specifically focused on assessing the social and economic conditions of fishermen in Medan, Deli Serdang, and Serdang Bedagai using the EAFM approach.

Based on this, it is important to conduct research on the socio-economic conditions of fishermen on the East Coast of North Sumatra. The aim is to understand the social and economic conditions of fishermen, stakeholder participation, and fisheries conflicts through EAFM, using indicators such as stakeholder participation, fisheries conflicts, the use of local knowledge in fish resource management, asset ownership, household income, and demand for fishery products. EAFM is chosen as the method because it offers a more comprehensive approach by considering the interactions between ecosystem, economic, and social aspects in fisheries management. This makes it more effective in addressing complex challenges, especially those related to the livelihoods of fishermen. Through this research, it is hoped that the existing problems and challenges can be identified, and sustainable solutions can be developed.

2. Method

This research took place in three locations: Medan, Deli Serdang, and Serdang Bedagai. The data used are primary data and secondary data. Data collection was conducted using field observation techniques, interviews with participants, and literature studies. Data collection aims to obtain information related to the social and economic aspects of the community in fish resource management. The social aspects include community participation, conflicts in fisheries, and local knowledge, while the economic aspects encompass asset ownership, fishermen household income, and the contribution of fishery product sales. Interviews were conducted with relevant stakeholders, such as the Marine and Fisheries Department, PSDKP supervisors, fishermen, community leaders, village heads, and NGOs in the East Coast of North Sumatra.

The study involved 64 respondents, consisting of fishermen (34 from Serdang Bedagai, 12 from Deli Serdang, and 18 from Medan), and 2 representatives from the Fisheries and Marine Department of each research area. The criteria for fishermen respondents were those who had lived in the area for at least 5 years. Field observations were carried out to assess the social-economic conditions of the fishermen, such as fishing gear, boats, settlement environment, and catch sales. Semi-structured interviews were used to gather more in-depth information. The limitations of this study include sample size, seasonal variations, and potential bias in stakeholder responses. The data analysis procedure involved processing data, checking the completeness of questionnaire completion by respondents, checking the suitability of all answers from participants, verifying the relevance of answers, and adjusting data for consistency.

Furthermore, the data obtained was analyzed using the Ecosystem Approach Fisheries Management (EAFM) indicator assessment approach. The stages of EAFM analysis based on (Adrianto, et al, 2014) are as follows:
1. Identify criteria for each indicator from the economic and social aspects or domains as Table 1.
2. Assess the performance of each fisheries unit for each indicator tested.
3. Establishing reference points.
4. Scoring each indicator of the domain using the Likert scale based on ordinal scales 1, 2, and 3 according to the performance of each fishery unit tested.
5. Assigning a score for each EAFM attribute with scores for all attributes from all domains set in the range of 1-3.
6. Determining weights based on the ranking for each indicator of the domain.
7. Determining the level of connectivity or density between domains and indicators by determining the domain score from the results of cognitive mapping linkages between indicators.
8. Calculate the value of each indicator with the formula Indicator *Value = Weight x Score.*
9. Calculating the total value and composite value of each economic and social aspect or domain with the formula:

$$Nk - i = \frac{Cat - i}{Cat - imax} \; x \; 100$$

with:

N_{k-1} = Composite value on the "I" aspect
C_{at-i} = Total EAFM value of one attribute in the domain
$C_{at-1\;max}$ = The maximum score of an attribute in a domain obtained when all the attributes
       have a score of 3.

Table 1. EAFM domain assessment criteria

No	Domain	Indicator	Criteria	Weight
1	Social	Stakeholder participation	1 = less than 50% 2 = 50–99% 3 = 100%	40
		Fisheries conflict	1 = more than 5 times per year 2 = 2-5 times per year 3 = less than 2 times per year	35
		Utilisation of local knowledge in fish resource management	1 = none 2 = exist, but not effective 3 = exist and effectively used	25
2	Economic	Asset ownership	1 = asset value reduced (more than 50%) 2 = asset value remains (less than 50%) 3 = asset value increased (more than 50%)	45
		Fishermen household income	1 = less than the regional minimum wage 2 = equal to the regional minimum wage	30

	3 = more than the regional minimum wage	
Demand level (% of fishery products sold)	1 = 20% sold out 2 = 21-50% sold out 3 = 51-100% sold out	25

Source: Adrianto, et, al (2014) and Harahap, et al (2023)

Table 1 presents the assessment criteria in the *Ecosystem Approach to Fisheries Management* (EAFM), covering two main domains: social and economic. In the social domain, the indicators assessed include stakeholder participation, the frequency of fisheries conflicts, and the use of local knowledge, reflecting the importance of involvement and cooperation in managing fisheries resources. Meanwhile, the economic domain evaluates asset ownership, fishermen household income, and the demand level for fishery products, indicating the success of management in improving welfare and the economy. Higher weights are given to criteria that reflect the success and sustainability of management, both socially and economically.

10. Determining the total composite score of all domains studied, which is obtained from the average composite score of all domains. The results of the analysis are then displayed in flag mode as described in Table 2

Table 2. Domain and aggregate score limitations

Value Range		Flag Model	Description
Low	High		
1	20		Very Poor at implementing EAFM
21	40		Poor at implementing EAFM
41	60		Moderate at implementing EAFM
61	80		Good at implementing EAFM
81	100		Very Good at implementing EAFM

Source: Adrianto, et al, (2014)

Table 2 illustrates the value range and flag model used to assess the implementation of the *Ecosystem Approach to Fisheries Management* (EAFM), with evaluation categories based on the obtained scores. A range of 1-20 indicates very poor implementation, while 21-40 reflects poor management with many areas needing improvement. A range of 41-60 represents moderate implementation, where some aspects are good but still have room for improvement. A range of 61-80 indicates good management, although some areas still require strengthening, and 81-100 represents very good implementation, with effective and sustainable management. This assessment helps identify strengths and weaknesses in ecosystem-based fisheries management, encouraging improvements toward sustainability.

3. Result and Discussion
3.1 Overview of the number of fishermen on the East Coast of North Sumatra
The number of fishermen and capture fisheries production in the three regions can be seen in Table 3. The majority of fishermen in this area are small-scale fishermen using vessels of less than 5 GT. Fishing gears often used include gillnets, traps, purse seines and bottom longlines. Fishing is generally conducted in one-day trips or ten days in one trip, depending on the type of fish caught and the fishing gear used. Average catches vary depending on the fishing season, with a minimum range of about 100 kg to over 300 kg during the fishing season. However, during the non-fishing season, catches can drop dramatically to a maximum of 50 kg or even zero.

Table 3. Number of fishermen and capture fisheries production in 2022

No	City/ Regency	Number of Fishermen 2022		Total of Fishermen 2022 (person)	Total of Fishermen 2021 (person)	Capture Fisheries Production 2022 (tonnage)	Capture Fisheries Production 2021 (tonnage)
		Full time	Part-time				
1	Medan	8.750	3.810	12.560	12.570	27.085	31.838
2	Deli Serdang	11.754	23	11.777	13.177	32.852	37.812
3	Serdang Bedagai	8.035	1.866	9.901	10.171	26.460	24.181

Source: Processed from Satu Data KKP and BPS (2024)

Based on Table 3, it can be seen that the number of fishermen in 2022 in Medan, Deli Serdang, and Serdang Bedagai has decreased compared to 2021. The most significant decrease occurred in Deli Serdang, with a 10% decrease. The decline in the number of fishermen is influenced by several factors, namely water conditions, increased operational costs, and industry competition. These three factors have a direct impact on fishermen's income. As a result, some fishermen may choose to find other jobs due to the difficult economic situation faced in the fishing business.

The deteriorating water conditions have resulted in a decline in capture fisheries production. All participants in this study stated that water conditions have worsened and siltation has occurred, causing the volume of catches to decrease in the last 5 years. In addition, 89 per cent of research participants stated that the distance to fishing grounds has increased. This has resulted in fishermen having to fish by moving from one location to another. A total of 73% of fishermen fished within 1 to 15 miles, while the remaining 27% fished more than 15 miles away. In addition to fishing in mobile areas, 34 percent of fishermen also change their fishing gear according to the fishing season. This action is taken so that they can maintain the continuity of their fishing business and still earn income.

Increased operational costs due to the increase in fuel also caused a decline in fishermen's income. Although the government has issued a subsidised fuel policy for fishermen, it has not reached fishermen equally. The difficulty of obtaining recommendations to obtain subsidies and the fuel quota that does not match the needs of fishermen is one of the main problems faced. Competition from large industries also has an impact on the sustainability of fishing businesses carried out by small and traditional fishermen. These fishermen have to compete with big companies to catch fish. Sometimes, the fishing fleets of these large companies also fish in areas that are fishing areas for small and traditional fishermen. As a result, all the fish are caught by large companies, while small-scale fishermen do not get a fair share. This situation is exacerbated by the use of banned fishing gear, such as trawlers and clam tanks. The use of these two types of fishing gear not only exploits fish resources of various types and sizes but also damages the aquatic environment which in turn disrupts the ecosystem and sustainability of marine and fisheries resources.

3.2. Social and Economic Analysis
3.2.1. Social Analysis
Social conditions are assessed based on 3 (three) indicators, namely stakeholder participation, fisheries conflicts, and utilization of local knowledge in fisheries resource management (Harahap, et. al, 2023). The results of the composite analysis calculation for the social domain obtained a value of 55.55 with a moderate category in implementing EAFM. This result is slightly different from the research of Damanik, et al (2016) which found that the social domain in the waters of WPP 571 is in a good category. The difference is the frequency of fisheries conflicts that are currently increasing and the low and less effective use of local knowledge in managing fisheries resources in the three research locations. The complete social domain composite analysis can be seen in Table 4.

Table 4. Social domain composite analysis

Dimension	Indicator	Description	Score	Weight	Value	Composite
Social	Stakeholder participation	Stakeholder participation such as conflict resolution, monitoring, and counselling by the government on the use of prohibited and environmentally friendly fishing gear, fishing lines, training to improve fishers' knowledge and skills such as alternative livelihoods, technology in fishing, etc.	2	40	80	66,67
	Fisheries Conflict	Many conflicts occur, especially between small fishermen and large fishermen, or local fishermen and fishermen from other regions with a frequency of more than 5 times a year, such as fighting over fishing lines between small and traditional fishing boats and large fishing boats from the fishing industry, fishing with prohibited fishing gear, competition over fishing areas, and so on.	1	35	35	33,33
	Utilisation of local knowledge in fisheries resource management	Traditional ecological knowledge among fishermen includes an understanding of fishing seasons, weather patterns, fish migration, wind and wave movements, and the presence of birds or other fish to locate fish, as well as knowledge of fish habitats and abundance cycles. However, this knowledge has become less effective due to climate change, altered water conditions, and increased fishing competition.	2	25	50	66,67
	Total Social Dimension		**5**	**100**	**165**	**55,55**

Stakeholder participation aims to measure the activeness of stakeholders in fisheries management activities. From the research results, it can be seen that stakeholder participation in fisheries management in these three locations is classified as good with a stakeholder participation indicator value of 66.67. Forms of stakeholder involvement include joint supervision between the North Sumatra Provincial Maritime and Fisheries Service with Polairud and Lantamal every year, coaching and socialisation of fishermen by extension workers from the local government, provision of fishermen insurance assistance by the local government, and the active role of fishermen associations or organisations in conveying aspirations related to fisheries management. Harahap, et al. (2023) suggested that to increase stakeholder engagement, it is necessary to increase awareness of stakeholders in fisheries management.

However, although the stakeholder participation indicator is good, these efforts are insufficient to minimize the fishery conflict in this area. The indicator of fisheries conflict is 33.33, which means the frequency of conflict is high. The fisheries conflict indicator aims to identify conflicts that occur between fishermen due to the struggle for fishing areas and conflicts over the use of fishing gear. Data on fisheries conflicts obtained through interviews with fishermen indicate that the frequency of conflicts varies, but generally more than 5 times a month but never leads to anarchist actions such as what happened in 2022 where 2 units of mini trawl boats from Batubara district fished in the sea waters of Serdang Bedagai and the two boats were burned by fishermen from Serdang Bedagai.

In these three locations, there are frequent conflicts between small-scale fishermen and fishing companies over the use of fishing lines. Fishing fleets from fishing companies often fish in the fishing lanes of small-scale fishermen, resulting in competition for catches. In addition, fisheries conflicts also occur with fishermen who use prohibited fishing gear such as trawlers and clam tanks. The high frequency of conflicts is an indication that fisheries management is poor, especially in terms of monitoring and law enforcement. This can be due to

the limited frequency and area of supervision, limited funds and technology used for supervision, and inappropriate enforcement of laws and policies in the field.

The utilisation of local knowledge in fish resource management is an indicator of the extent to which local knowledge is used and how effective it is in fish resource management efforts (Budianto, et al., 2015). The effectiveness of the application of local knowledge in fish resource management activities determines the level of success. Local knowledge of fishermen in the three locations already exists, especially related to fishing areas during certain fish seasons, but this knowledge has not been effectively used due to dynamic weather and water conditions as well as fishing competition that encourages fishermen to force fishing rather than not getting any catch at all. The composite score for local knowledge is 66.67 in the good category.

3.2.2. Economic Analysis
Economic conditions were assessed based on 3 (three) key indicators, namely asset ownership, fishermen household income, and the level of demand which assesses the percentage of sales of catches (Budianto, et. Al, 2015). Overall, the economic domain obtained a weighted score in the good category in implementing EAFM with a total score of 66.67, as shown in Table 5.

The asset ownership indicator is a comparison between the number of productive assets owned by fishermen households at this time compared to the previous year. These productive assets include all assets used in fishing activities. The measurement of this indicator aims to assess the ability of fishermen households to improve their economic activities (Budiarto et al., 2015). The value of the asset ownership indicator obtained from the three research locations is 66.67, which means that there are no additional assets during the fishing business. This indicates that the income earned by fishermen is only enough to fulfil their basic daily needs, operational costs of fishing, and maintenance costs of productive assets, which is insufficient to increase the number of productive assets they own. In other words, while they may be able to survive with the income earned, they have difficulty raising capital to further develop their businesses or expand their productive assets. The average types of productive assets owned by fishermen include boats, engines, and fishing gear.

Tabel. 5 Composite analysis of economic domain

Dimension	Indicator	Description	Score	Weight	Value	Composite
Economic	Asset ownership	Fishermen's productive assets do not increase or decrease (fixed assets). **Result**: there is no increased assets compared to the previous year.	2	45	90	66,67
	Fishermen household income	The average income of fishermen per month in 1 year is less than the minimum wage. **Result:** The average monthly income of fishermen is IDR 3,666,600 per month in one year, while the minimum wage is IDR 3,769,082 per month.	1	30	30	33,33
	Demand level (% of fishery products sold)	90% of the catch is sold and taken by collectors, sold directly to consumers or TPI. **Result:** Around 92% of fishermen's catches are successfully sold through various channels such as collectors or middlemen, fish auction sites (TPI), or directly to consumers. The rest of the catch is processed for self-consumption or sold.	3	25	75	100
Total Economic Dimension			**6**	**100**	**195**	**66,67**

Source: Analysis Results (2024)

The indicator of fishermen household income is the total income received by fishermen livelihoods assessed using the regional minimum wage standard. The fishermen's household income in the three locations scored 33.33 in the poor category because the fishermen households income was still below the regional minimum wage. This score indicates financial hardship. The income earned by fishermen from fishing is uncertain,

depending on the season. During the fishing season, which generally runs from November to February, fishermen can earn a high income. However, during the lean season, which occurs from March to October, fishermen's income can decline by up to 30%. The calculation of fishermen's income is based on the average catch season income of Rp 6,000,000 per month for 5 months from October to February and non-catch season income of Rp 2,000,000 per month for 7 months from March to September so that when converted for one year, the income of fishermen is Rp 3,666,600 per month and is below the standard regional minimum wage of Rp 3,769,082. In addition, low fishermen household income is also due to the lack of alternative livelihoods for fishermen. From the research results, only 53% of fishermen have other sources of income, such as trading, farming, motorcycle taxis, and opening machine or fishing gear repair services.

The demand level indicator was conducted by measuring the percentage of catches sold (Mardyani, 2020). This indicator's score reached 100, signalling an excellent category. More than 90 percent of fishermen's catches are sold through various channels such as collectors or middlemen, *Tempat Pelelangan Ikan* (TPI), or directly to consumers. The rest of the catch is processed for self-consumption or sold. However, a high level of demand does not guarantee that fishermen's needs will be met. Although a high level of demand is a positive thing, it does not guarantee that the income earned by fishermen can fully fulfil the needs of fishermen. A high level of demand indicates that there are ample market opportunities to accommodate the catch. However, it is important to remember that the supply factor or the amount of catch is also very influential on the total income earned. Even with significant demand, low catch volumes due to overfishing or environmental factors result in income limitations. Income limitations have a corresponding impact on asset ownership. Due to meagre income, fishermen are unable to increase their assets. The landing and selling activities of fishers' catches in the study area can be seen in Figure 1.

Figure 1. Fish landing and sales activities at TPI
Source: Field observation (2024)

After conducting thematic composite analyses for social and economic aspects/domains, the next step is to estimate the aggregate performance of fisheries management areas using inter-thematic composite techniques. The estimation results from each thematic aspect are then combined into one index with the assumption that there is no difference in weight between each aspect. In other words, in the aggregate analysis, all aspects are considered important. The results of the aggregate composite analysis can be seen in Table 6.

Table. 6 Aggregate composites of the social and economic domain

Domain	Domain Composite Value	Status
Social	55,55	Moderate
Economic	66,67	Good
Average Aggregate	**61,10**	**Good**

Overall, the status of fisheries management in the three research sites assessed from the social and economic aspects or domains is categorized as good with a value of 61.10 However, this value is close to the medium category so efforts are needed to improve EAFM management. The results also indicate that there are several challenges and potential improvements that need to be considered to improve social and economic conditions related to fisheries management in the region. More effective policy implementation, empowerment of fishing

communities, improvements to infrastructure, or a more inclusive approach to fisheries-related decision-making processes may be needed for improvement.

The findings from this study align with other research on small-scale fisheries in Indonesia, such as the work of Prihandoko, et al (2012), who observed similar economic struggles and stakeholder conflicts and Damanik, et al (2016), who evaluate fisheries management in WPP 571 thoroughly. However, the fisheries management in research sites face unique challenges, such as increasing distances to fishing grounds and significant competition from industrial fleets. The contrast between the social domain (moderate) and the economic domain (good) suggests a need for improved conflict resolution and more effective local knowledge application to bridge the gap between social and economic conditions. Fisheries management in research site shows a need for greater stakeholder engagement and enhanced policy implementation, especially regarding fuel subsidies, conflict mediation, and sustainable resource management practices.

4. Conclusion

Fisheries management in Medan, Deli Serdang and Serdang Bedagai faces various challenges, including a decline in the number of fishermen and production of capture fisheries, caused by deteriorating water conditions, siltation, rising operational costs, industry competition and the use of prohibited fishing gear. Although the social and economic conditions of fishermen are stable, two key indicators, fisheries conflict and fishermen household income, remain in the medium category and require attention for development. Increasing household income can be achieved by expanding training for alternative livelihoods, facilitating access to capital through fishing cooperatives, and promoting sustainable fishing practices. Future action steps are needed to expand EAFM assessments to other fisheries sectors, pilot interventions that integrate alternative livelihoods and sustainable practices, and strengthening governance and law enforcement are also critical for long-term fisheries sustainability.

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