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Vulnerability Analysis and Adaptive Capacity of Small-Scale Fishermen in Tambakrejo Fishing Village, Semarang, Central Java, Indonesia

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Abstract: This study identifies the perceptions and resources of small-scale fishermen about the adaptive capacity of small-scale fishermen in Tambakrejo Fishing Village using primary and secondary data. Fishermen respondents were selected using the accidental sampling method and the analysis used a mixed method approach. The number of respondents used in this study was 60 respondents. The purpose of this study is to explore the vulnerability of small-scale fishers and identify the adaptive capacity of small-scale fishing households. The criteria are grouped into 5 aspects: natural, social, economic, institutional and technological. Their adaptive capacity has the potential to help them grow resilience.

Keywords: adaptive capacity, vulnerability, Tambakrejo, Indonesia.

Introduction

Tambakrejo Fisherman Village, which is located in Central Java Province, precisely in North Semarang District, Semarang Regency, is dominated by small-scale fishermen. Most fishermen in the region have engine boats, fishermen empowerment through Joint Business Groups (KUB), and shellfish farmers. Indonesian small-scale fishermen catch fish for daily needs, without or with fishing boats of less than 10 gros tons (GT), while few fishermen have boats above 5GT. Therefore, from this data, it can be seen that most of the fishermen in Tambakrejo Fisherman Village are small-scale fishermen. In fisheries, vulnerability is caused by the presence of a combination of natural disasters and technology beyond human control. From the perspective of social vulnerability, various economic, social, institutional, and technological factors can limit people's ability to have a decent livelihood. In small-scale fishing communities, individuals may be less able to decide decisions. Small-scale fishermen have relied on marine resources for their livelihoods for decades. These resources make many contributions to society, culture and the economy, especially in terms of employment, food security and income (Belhabib D, 2005). Milan (2019) classifies domains related to fisheries natural resources: social, economic, institutional, institutional and technological domains. The social sphere includes kinship, association, and networking in fishing communities. The economic domain means savings, access to credit, loans, and profits. The institutional domain refers to the role of community-based rules and state regulations that affect access to natural or financial resources. The technology domain pays attention to the important assets needed to develop fishing activities. Although fishermen are vulnerable, they have adaptive capacities and resources that can be maximized. Therefore, current studies explore the vulnerabilities of small-scale fishers and identify the adaptive capacity of small-scale fishing households. In this regard, the study is able to explore the vulnerability of small-scale fishers and identify the adaptive capacity of small-scale fishing households.

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Ingredients and methods

Description of the location of the study.

This study took place in the northern coastal area of Central Java. This research was conducted in the Tambakrejo Fishing Village. The following is a map of the locations used in this study.

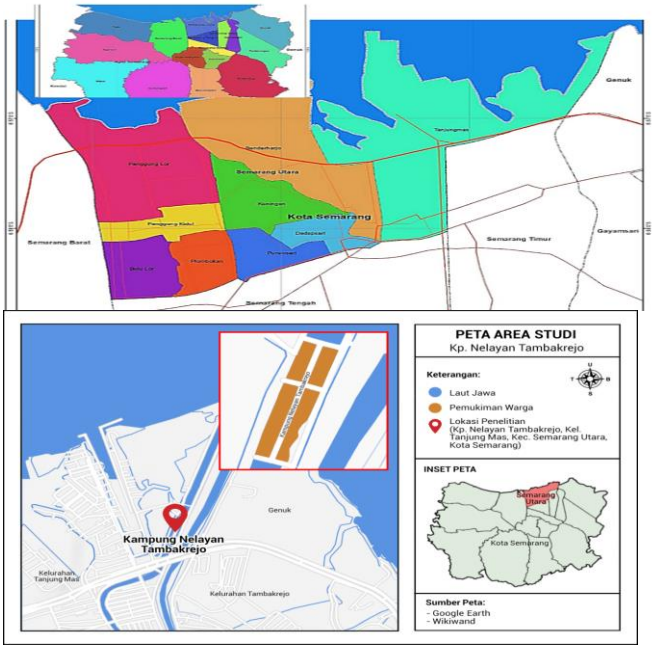

Figure 1. Study Location in Tambakrejo Fisherman Village, Semarang, Central Java, Indonesia.

Tambakrejo is one of the coastal areas that has the main function as a residential area, ponds and trade, especially marine products. This area is synonymous with tidal flooding problems. This area has a fairly high activity, because it has a high access value, its strategic location, close to the center of activity, the city center and transportation centers. The dynamics that occur between the port of Tanjung Mas and the industrial area, the Banger river and the BKT channel directly or indirectly affect the condition of settlements in Tambakrejo. This area is faced with declining environmental conditions due to tidal flooding and *land subsidence*.

Materials and Methods.

Data Type and Data Source

The study is based on primary and secondary data. Primary data are obtained by the method of structured interviews. Theespondent in this study consisted of 60 people in Tambakrejo who were selected by accidental sampling. Secondary data were obtained by conducting literature reviews and previous research.

Data Collection Methods

The method used in this study is a combination of quantitative and qualitative analysis. The primary data isprocessed through a structured interview mechanism with a questionnaire. Toanswer the objectivesof our research to collect primary datathrough observation (field surveys) and interviews and using *photovoice* techniques. Respondents were interviewed using semi-structured questionnaires and in-depth interviews to get a clearer picture for qualitative analysis.

Data Analysis Methods

The method used in this study is a combination of quantitative and qualitative analysis. The quantitative approach is carried out through descriptive statistics to answer the research objectives. The first goal is to identify fishermen's perceptions of what makes them vulnerable. The second objective of the study was to identify the adaptive capacity of small-scale fishing households. Qualitative approach through simple triangulation with the help of location maps. Toanswer the objectives of our study using the method of collecting primary interviews through *indepth* interviews and photovoices.

Result

The waters of Tambak Tambakrejo are used as fishing grounds. According to local fishermen, the waters of Tambak Tambakrejo are very productive. However, increasingly unpredictable weather changes and erratic sea waves and coastal siltation are prompting small-scale fishers to look for alternative sources of income. This can be seen from the fisherman's side job, which is to make a green clam pond. Green mussel ponds are considered easy and effective to be used as a side livelihood. Fishermen only need to plant bamboo in the place of the pond that has been made. Green kerang mbecome the main side income of small-scale fishermen.

Figure 2. The results of green clam ponds in Tambakrejo Fishing Village.

Figure 3. Coastal environment in Tambakrejo Fishing Village

Tambakrejo Fishing Village is adjacent to the East Canal Flood (BKT) and Muara Angke River which causes the consequences caused, namely silting around the fishing boat place to go to sea. If this silting occurs, then fishermen cannot go to sea and must first be pushed towards the sea so that they can go to sea. In addition, the waste carried by BKT and Muara Angke River also affects the accumulation of waste around the coast in Tambakrejo. The pile of garbage, apart from coming from activities from the community who litter, is also one of the dampak of tidal floods in Tambak Rejo. Garbage from upstream is carried by the current to the riverbank in Tambak Rejo. These wastes cause pollution on the coast of Tambak Rejo, so the catch is not optimal because of this. It can also be seen in the picture, the Rob flood caused serious damage to the fishing equipment of the fishermen in Tambak Rejo. Those who depend only on the lives of fishermen will suffer losses as a result of the damage. Their income will decrease, because they have to repair or even have to change their equipment so that they can go to sea again. Many communities depend only on the lives of fishermen, it can be seen in the picture that many boats and other equipment are seen in the picture

Characteristics of fishermen. As shown in Table 1, the socio-demographic profiles of respondents are: gender, age, education level, marital status, number of dependents, fishing gear, and low-income side hustle.

Table 1. Socio-demographic profile.

Variable	Description	Frequency	%	Information
Age (years)	<30	12	20	Min = 17
	30-40	19	31,67	Max = 59
	41-50	21	35	Average = 37
	>50	8	13,33	
Gender	Man	42	70	
	Woman	18	30	
Level of Investigation	0			Min =0
	1-6	20	33,33	Max = 12
	7-9	23	38,33	
	10-12	17	28,33	
	>12			
Income	<500.000	1	1,7	Min = Rp500.000
	500.000 - 1.000.000	1	1,7	Max =Rp3,000,000

Variable	Description	Frequency	%	Information
	1.000.000 - 2.000.000	23	38,33	
	2.000.000 - 3.000.000	33	55	
	>3.000.000	2	3,3	

Source: Primary Data (processed)

Table 1 shows a summary of the characteristics of fishermen in the Tambakrejo Fishing Village. The age range of respondents is mostly in the range of 30-50 years, with the average age of 37 years being the productive age. Fishermen's education level: 37.3% of fishermen are educated 7-9 years (SMP). The income level can reach IDR 2,000,000 when the season is good. However, if there are big waves and storms, they can't even go to sea.

This research was conducted to determine fishermen's perceptions of vulnerability. Vulnerability is measured based on small-scale fishers' perceptions of the impact of tidal flooding. The vulnerability experienced by fishermen was identified by Prateep & Berkes (2019) from natural, social, economic, institutional and technological factors. Fishermen's perception of this insecurity factor is standardized through adjustment, in order to obtain objective results. Small-scale fishers' perceptions of vulnerability factors are summarized in the table below.

Table 2. Evaluation of Socio-economic-ecological Vulnerability of Fishing Communities in Tambakrejo, North Semarang.

Evaluation of Social Vulnerability-E konomi-E cology of Fishing Communities in Tambakrejo, North Semarang							
Aspects	**Vulnerability Indicators**	**(%)**					**Average**
		1	**2**	**3**	**4**	**5**	
Nature	Banjir rob and puddles			13,6	28,8	57,6	4,13
	Fishm usim is difficult to predict		49,2		50,8		3,03
	Season changes are difficult to predict		18,6			81,4	3,6
	Highand unexpected bang		5,1		88,4	6,8	3,63
	Sumber damaged natural power		1,7		98,3		3,96
Social	Regulasi government less supportive of small fishermen		20,3		79,7		3,6
	Asmall fisherman does not have insurance		45,8		52,2		3,10
Economics	Thefishermen's income from fishing has not met		47,5		52,5		2,93
	Seasonal fish sales		67,8		32,2		2,67
Institutional	Therole of the government in improving the welfare of small-scale fishermen		10,2		89,8		3,60
	Participation of joint business groups for fishermen for empowerment		8,5		91,5		3,71
Technology	The fishing gear used is still feasible		71,7	21,7	6,7		3,23
	Nelayan has no modern technology		10		90		3,65
	Sulitnya adapts to modern technology		25		75		2,20

*1: Strongly disagree *2:Disagree *3: Don't know *4: Agree *5:Very Agree

Social factors, according to the perception of fishermen's vulnerability, are regulations that are less supportive, such as the increase in fuel prices which are the source of fuel for fishing boats to go to sea. Insurance has been issued by the Fisheries and Marine Service. Respondent 31 (Yanto) also mentioned that the problem of small fishermen in terms of health insurance is the difficulty in managing it, because of the distance to the health insurance office. They do not have a strong motivation to visit the insurance offices of the fishing villages. Meanwhile, from an economic point of view, the perception of fishermen's insecurity is focused on insufficient income, seasonal sales, fuel scarcity, lack of money to go to sea and the development of joint venture groups. The majority of respondents assumed fluctuations in their income were erratic. In terms of technology, fishermen's vulnerability is felt through indicators of old fishing gear, less modern technology and difficulties in understanding technology, as well as the expansion of joint business groups for fishermen as a suggestion for fishermen empowerment.

Assessment of adaptive responses. The adaptability of society is a key aspect of building socio-economic resilience realized through collective action. One way to analyze the trends that shape local adaptive responses is to use various adaptive capacity instruments. Each instrument reveals information that supports closing the gap between the goals and actions of the human beings participating in the attribute system of adaptive capacity. These instruments control the extent to which a community can exercise resilience and adapt or change in response to change. The following are aspects of such adaptive capacities: response diversity, collaborative capacity, connectivity, abundance/reserve and learning capacity (Kerner D.A., 2014; Kaur, 2020)

Diversity of responses. Response to changes in socio-ecological systems can involve aspects of social and ecological subsystems. Components, such as organically built people and infrastructure, workforce and expertise, multilevel and institutional actors, formal and casual actors play an important role in responding to change. In addition, the diversity of livelihoods and incomes is a common indicator used to determine the diversity of responses within the social subsystem, in addition to economic opportunities, the degree of dependence on natural resources, migration patterns and the willingness to change(McLeman & Hunter, 2010) .

Identifying the diversity of livelihoods in a system allows an understanding of possible social inequalities and the uneven distribution of opportunities despite changes (Leslie & McCabe 2013). The response was demonstrated from the results of semi-structured interviews.

Connectivity. With the development of activities around tambakrejo waters, the community can adapt by increasing connectivity. It is identified by increasing the number of associations of the local level, raising awareness and increasing the frequency of community meetings during ongoing changes or when encountering an unfortunate situation.

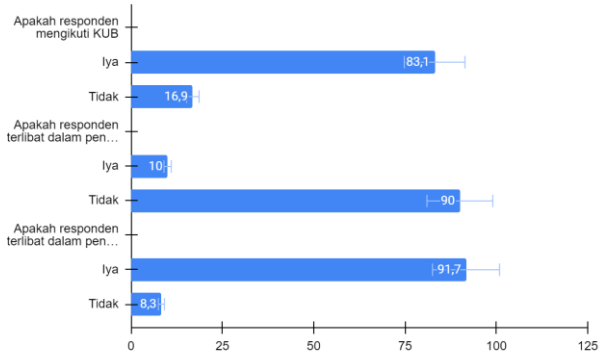

Figure 4. Fisheries information on collaborative capacity (n=60).

Collaborative capacity. Collaboration within communities often depends on human systems and their level of involvement in socio-ecological systems. The contribution of fishermen becomes a parameter of collaborative capacity assessment. Based on figure 5, as many as 90% of fishermen do not participate in innovation decision-making within the community. However, only 8.3% of fishermen are also not involved in making natural resource management decisions.

Respondents were asked questions about the assets owned. They show household appliances and access to water and electricity. Based on asset

ownership, most fishermen respondents own a motorcycle (i.e. 90% of fishermen respondents). Meanwhile, 83.3% of respondents own a house or land around the waters of Tambakrejo, and have a smartphone-type communication device. Based on ownership of household appliances, fishermen respondents stated that they had gas stoves, televisions, and access to electricity. Respondents who owned a refrigerator were 63.3%. 98.4% of respondents have a fan. Gas stove ownership was 96.7% of all respondents, and 95% of respondents stated that they owned a TV. For water access, as many as 86.7% of fishermen respondents have clean water sources from PDAMs, and the remaining 13.3% of people use wells to get clean water. Respondents had access to electricity of 98.4.

Learning capacity. We must understand the learning capacity of the local community, which takes into account several aspects, such as the level of education, access to resources and cultural memory(Kaur, 2020). The indicators we use are how and where do they communicate?

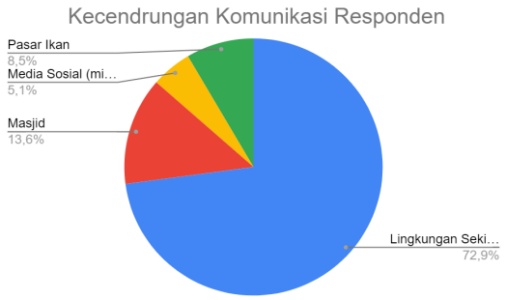

Figure 5. Fishermen's preference for communicating (n=60)

As shown in Figure 5, When selecting references based on location to communicate, respondents tend to choose a method of communication by chatting live. As many as 72.9% of respondents decided to communicate directly, while 5.1% of respondents communicated through social media or WhatsApp. As many as 13.6% of respondents decided to communicate in mosques through worship activities such as congregational prayers and regular recitations. 8.5% of respondents chose to speak in the market/TPI, the parent market, or at the port.

Fishermen Mitigation Strategies. To ensure long-term community mitigation, it is necessary to monitor and evaluate the policies that have been implemented, to determine whether this needs to be continued or stopped. It is necessary to empower women to be able to provide more guarantees to meet the needs of their families, so that they can help their husbands not only as pre-harvest, but also post-harvest to bring additional income to the family. Acknowledging and including women in fisheries management is essential for a sustainable and equitable fishing industry. In addition, fishing is a very risky job so it is important for fishermen to have life insurance and also health insurance to offset the risk of employment they receive. With a high level of occupational risk, the fishing profession also requires special protection. It is important for fishermen and their families to have life insurance that can reduce the burden on the family in case of danger. In addition, it is also important for local communities to have a sense of belonging and inclusion, by improving fishermen's communication patterns with appropriate policy makers.

Small-scale fishermen in Kampung Nalayan Tambakrejo are worried about the silting of their port, making it difficult to get in and out of the port. To ensure long-term community empowerment, it is necessary to monitor and evaluate the policies that have been implemented, to determine whether they need to be continued or stopped. Furthermore, key figures stressed the need for the creation of new jobs to diversify professional opportunities for fishermen and to secure stable incomes in different seasons or conditions. Aquaculture and tourism development are two priorities of the government. After that, it is necessary to empower women so that they can provide more guarantees for their family's livelihood, so that they can help their husbands not only as pre-harvest, but also post-harvest to bring additional income to the family (Kusumawardhani & Susilowati 2021). Acknowledging and including women in fisheries management is essential for a sustainable and equitable fishing industry. Furthermore, fishing is a very risky job so it is important for fishermen to have life insurance and also health insurance to offset the risk of employment they receive. With a high level of occupational risk, the fishing profession also requires special protection. It is important for

fishermen and their families to have life insurance that can reduce the burden on the family in case of danger (Rani 2016). In addition, it is also important for local communities to have a sense of belonging and inclusion, by improving fishermen's communication patterns with policy makers, so as to create harmony and integration in overcoming vulnerability problems that occur towards feasibility.

Discussion. Although fishermen are not part of the poorest communities, they are communities vulnerable to change. Thus, the categorization of vulnerabilities should be based on issues relevant to a particular incident or type of emergency. Furthermore, we know that all groups of people, men and women, young and old, rich and poor, may be vulnerable in different ways. We are all prone to some weakness. Therefore, a method is needed to better assess and prioritize vulnerabilities. The identification of vulnerability factors based on the work of Milan (2019) is divided into natural, social, economic, technological and institutional. It is these factors that develop the concept of Nayak & Berkes (2019), dividing it into material, relational, and subjective aspects.

Perceptions of vulnerability vary for each community. For example, in one coastal area, they could be vulnerable to climate change. Years of experience in deep-sea fishing make small-scale fishermen live in comfort zones and are reluctant to adopt improved methods. The ease of using existing technology is also seen in fishermen around the Tambakrejo area who argue that switching to modern technology is not urgent and interferes with their daily lives. Years of experience in deep-sea fishing make small-scale fishermen live in comfort zones and are reluctant to adopt improved methods.

The perception of fishermen's vulnerability, as recorded in this study, considers aspects of nature to be the most disturbing factor. Unpredictable climate change and difficult-to-detect seasons make small-scale fishers most vulnerable to impacts. Adaptive response capacity is critical to proper policy setting. Migration is just one possible adaptive response from fishing communities. Interestingly, small-scale fishermen in Tambakrejo still lack awareness of health insurance. However, health insurance turns out to be beneficial for them to improve the well-being of life. They also have an average level of education for elementary school graduates, just like the farming community in Indonesia, with a low average education level. Building adaptive capacity to respond to vulnerabilities in small-scale fishers in Tambakrejo requires complex adaptive responses; for example, managing the impacts of climate change by improving access to alternative resources and livelihoods may require adaptive responses in other systems, such as local cultures, values, and institutions. Interrelated feedback in the adaptive capacity of social systems in this research region indicates the need for a continuous review and response process. Faced with uncertainty due to weather and government policies, fishermen take side jobs or reserves. Weather and natural conditions can also cause fishing gear such as boats or nets to be damaged and unable to catch fish, being one of the factors that cause fishermen and their families to lose their livelihoods (Safitri 2018). Fishermen have not been actively involved in local management.

Building adaptive capacity to respond to vulnerabilities in small-scale fishermen in Tambak Rejo Fishing Village requires complex adaptive responses; for example managing the impacts of climate change by increasing access to alternative resources and livelihoods may require adaptive responses in other systems, such as local cultures, values, and institutions. Interrelated feedback in the adaptive capacity of social systems in this research region indicates the need for a continuous review and response process. Understanding vulnerabilities, responses and adaptive capacities can be used as an initial basis for establishing strategic policies to support the transition.

Conclusion

The results of the analysis show that vulnerability based on the perception of fishermen around the Tambakrejo Fishing Village is dominated by natural and social factors. Adaptive capacity is a way to measure

vulnerability and can also be considered an important attribute of resilience. In addition, adaptive responses to change are mainly limited to livelihoods. Alternative sources of income, such as jobs available in the tourism sector, although highly dependent on natural resources, can be a viable solution for this community of professionals. Adaptive responses are characterized by diversity, collaborative capacity, connectivity, abundance/backup and learning capacity. Respondents' adaptive strategies are: denial of migration, acceptance of employment opportunities, local organizations for communication and information, and a willingness to increase their participation in decision-making in their local communities, particularly regarding environmental management. In determining vulnerabilities and adaptive capacities, it is carried out by improving strategies to achieve survival during uncertain conditions. Future research is needed on the perception of specific vulnerabilities and adaptive capacities in different regions and communities, to inform and adjust policies.

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Conflict of interest. The authors state there is no conflict of interest.

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