Impact of climate change on small-scale fishers and adaptation strategies in Bengkulu, Indonesia

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Abstract. Climate change presents a significant global challenge for developing countries, especially Indonesia. However, this challenge also presents an opportunity for positive change, particularly in determining long-term investment decisions, including climate change adaptation and resilience measures. Uncertainty about future climate conditions makes the design of climate-supportive adaptive structures difficult and expensive, but it also opens the door for innovative solutions. This study reflects the perspective of small-scale fishers regarding the impacts of climate change and identifies the primary adaptation strategy. A survey was conducted in 700 small-scale fishery households to collect data on socioeconomic factors, climate change perceptions, and adaptation strategies. The research results show that 100% of small-scale fishers in the Bengkulu coastal area perceive climate change as harming their capture fisheries businesses. The level of adaptation carried out by small-scale fishers in the coastal regions of Bengkulu City could be significantly higher, as evidenced by the fact that only 15% of fishers have made efforts for climate change adaptation. Age, formal education, organizational membership, and access to climate information are crucial factors for adapting small-scale fishers to climate change. This research found that small-scale fisher's awareness of climate change is deficient. Maximizing the use of fisher's organizations and access to climate information can be helpful to climate change.

1 Introduction

Wealth in the fisheries sector is essential for society's welfare and can potentially become the main driver of the Indonesian economy. This is based on the fact that Indonesia has rich wealth in the fisheries sector, both in quantity and diversity [1]. The economic and social functions in the fisheries sector must be distinct from the influence of changes in natural conditions, one of which is climate change. According to [2], climate change severely impacts sea fish catches, and sea fish catches determine the welfare of fishermen. Climate change is a phenomenon caused by global warming. These climate changes include changes

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in erratic weather, increasing seawater temperatures, increasing extreme weather, changing rainfall patterns, and high waves [3, 4].

Bengkulu Province is one of Indonesia's zones that is defenseless from climate change. This contention is based on the reality that the Bengkulu Area is the center of the world's climate. The waters in the Bengkulu Area assemble four able sea streams that point to dissipating and handling rain clouds in the rainy season and influencing the world climate [5]. An honest-to-goodness climate change happens within the coastal range of Bengkulu, specifically climate changes. In their everyday angling exercises, anglers, mainly small-scale fishers on the Bengkulu coast, depend on the climate. Erratic climate changes have diminished the productivity of fishers on the coast of Bengkulu City. This could be concluded since anglers within the coastal region of Bengkulu seem not to go to the ocean due to the extraordinary climate. The most recent case related to extraordinary climate happened from November 2022 - January 2023 [6].

The vulnerability of fishers, particularly small-scale fishers, due to climate change requires direction and bolstering to expect the impacts of climate change. One frame of expectation is arranging endeavors to alter or adjust. Adjustment within the confront of climate change is an exertion to adapt that's carried out reflexively or planned to respond to climate change [7]—ecology, social, and economic variables impact adjustment in confronting climate change. Adjusting to climate change can minimize the negative impacts of climate change both presently and in the future [8]. This research aims to analyze 1) the impact of climate change felt by small-scale fishers and 2) the adaptation strategies carried out by fishers and the factors that influence climate change adaptation.

2 Methodology

This investigation was conducted in Bengkulu area, which incorporates Bengkulu City, Central Bengkulu Rule, North Bengkulu Rule, Mukomuko Rule, Seluma Rule, South Bengkulu Rule, and Kaur Rule (Figure 1) with the thought that Bengkulu Territory is considered the world's climate center, which is the waters in Bengkulu Territory are an assembly put for four sea streams, making them exceptionally helpless to climate alter [5]. Inspecting in this investigation employs coincidental inspecting, which could be a sampling technique that's based on chance; that's, anybody who incidentally meets the analyst can be utilized as a test in case it is seen that the individual they meet by chance is reasonable as an information source concurring to the criteria, which may be small-scale fishers who lock in in everyday activities (one-day angling). This strategy is utilized since analysts have restrictions in knowing the precise number of a considerable populace. The overall respondents in this research were 700 small-scale fishers.

The impact of climate change on capture fisheries businesses as perceived by fishermen was studied by asking questions related to the impact of climate change, which was then measured using a Likert scale, namely strongly agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1). The number of indicators of the negative impact of climate change on capture fisheries businesses perceived by fishers can be categorized as:

a) The total perception score is > 50%, an indicator that means climate change has a negative impact
b) The total perception score is ≤ 50%, an indicator that means climate change has no negative impact

Adaptation to climate change is studied based on the adaptations fishermen can make and carry out to adapt to climate change. A multiple regression analysis model is used to determine the factors that influence the adaptation of small-scale fishermen to climate change, which involves various independent variables from previous research, such as age [9], education [10], experience as a fisher [11], household size [12], fisher's perceptions

regarding the impact of climate change [12], organizational participation [11], and access to climate change [13].

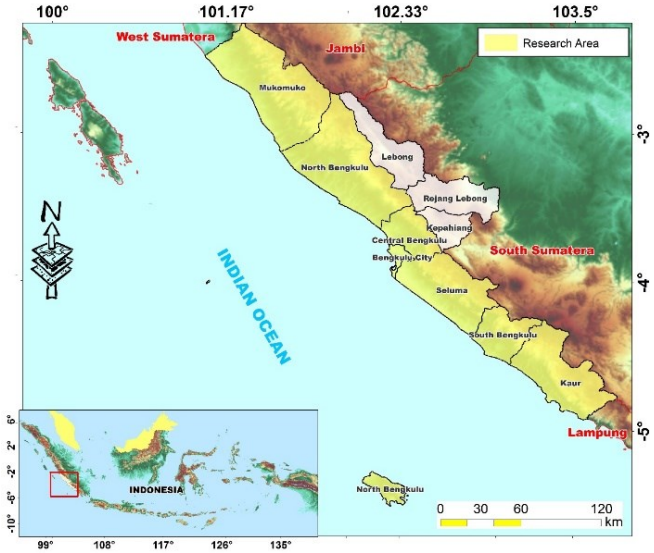
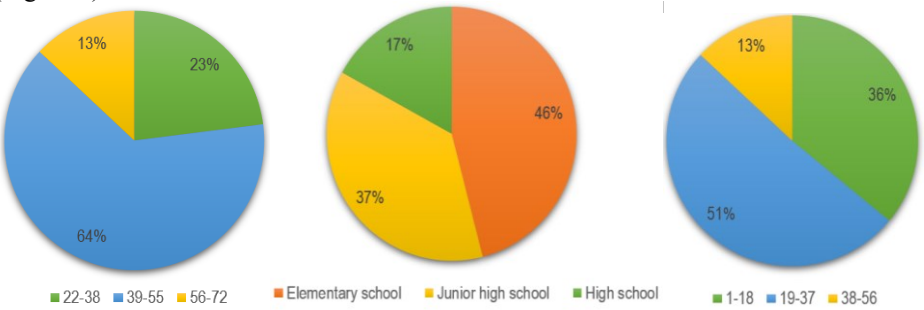


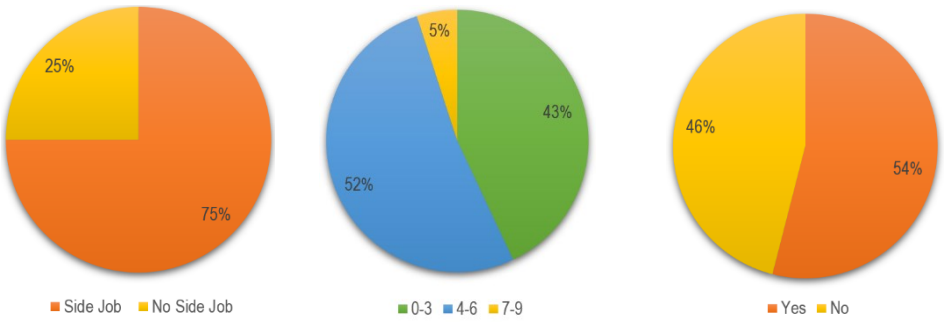
Fig. 1. Research areas

3 Results and discussion

3.1 Socio-economics characteristics of small-scale fishers

The socioeconomic characteristics of the respondents and the household include age, education, fishing experience, household size, membership organization, and a side job (Figure 2).





(d) (e) (f)

Fig. 2. Percentage of the respondents based on socio-economics characteristics (source: field survey, 2024): (a) age (years), (b) education (grade), (c) fishing experience (years), (d) side job, (e) household size (person), (f) group membership

3.2 Climate Change Impacts

The research results stated that all small-scale fishers (100%) in the Bengkulu coastal area concluded climate change harmed capture fisheries businesses. This is in line with research by [4], which states that climate change harms the socio-economic life of the community, especially that of fishers. According to the fishing community, climate change cannot be determined and predicted currently. Therefore, when it is cloudy and windy, fishers prefer not to go to sea, which they fear will endanger the fishers themselves.

Most fishers agree that climate change causes a decrease in fish production in the sea (Table 1). Climate change causes seawater temperatures to rise, resulting in a decline in fish populations. Apart from that, high rainfall and the difficulty of fishers determining the right time to go to sea result in fishers needing to catch fish optimally. This is also in line with research by [14], which states that forms of climate change in the form of high rainfall, wind speed, and high waves greatly influence fisher's decisions about going to sea so that they directly affect the production of fish that will be caught.

The research results (Table 1) also show that climate change causes a decrease in potential catches. Small-scale fishers feel this impact; initially, fishers often catch large fish with high marketability. However, due to climate change, potentially expensive fish to sell have decreased to the point that they are difficult to catch. In the eastern season, the fish catch will be abundant, and fishers usually easily catch types of fish such as tiger grouper, ketarap, and sunu, which have very high selling prices of up to Rp. 70,000-Rp. 80,000 per fish. However, the negative impact of climate change makes it difficult to find types of fish with high marketability [15]. Climate change for small-scale fishers makes determining the right time to go to sea challenging. Besides that, changes in water temperature, which damage coral reefs due to climate change, cause a decline in fish populations and directly impact fishermen's income (Table 1). Small-scale fishers have to think about the unexpected costs of ship damage due to high waves from climate change, and fishers are also hit with catches that do not match their expectations. This is also the opinion of [16], who states that climate change negatively impacts coastal areas, such as reducing the income of fishing fishers due to changes in water temperature, which damages coral reefs and causes a decline in fish populations.

Table 1. Indicators of small-scale fisher's perceptions of the impacts of climate change

Climate Change Impacts	% (n = 700)
It is difficult for fishermen to predict when to go to sea.	75
It is difficult for fishermen to determine the direction of the wind.	25
It is difficult to predict the arrival of a storm.	72
Production decline	99
Decreased potential catch	99
Damage to coral reefs	49
Difficulty determining the fishing area	86
The level of abrasion and rob is getting higher.	73
The risk of going to sea is getting higher.	94
Increased operational costs	98
Decrease in the income of small-scale fishers.	98

Source: Primary data is processed, 2024

3.3 Adaptation Strategies of Small-scale Fishers

The level of adaptation of small-scale fishers is how much effort fishers make to adapt to the impacts caused by climate change. Fishers are encouraged to adapt to climate change to overcome the impacts and increase their ability to survive fishing activities at sea. The research results show that only 15% of small-scale fishers adapt to climate change (Figure 3). Fisher's low level of adaptation is due to limited financial capabilities and human resources. Small-scale fishers often use adaptation strategies, including seeking information about weather and climate change, changing fishing grounds, using geoinformation and communication system technology, and adjusting fishing times [17].

Small-scale fishers in the Bengkulu coastal area still need to fully understand the steps they should take to anticipate climate change. Factors thought to influence their adaptation were analyzed using multiple linear regression models. The model in this research has first been tested for classical assumptions, which include heteroscedasticity, multicollinearity, and autocorrelation.

The research results (Table 2) show that age, education, group membership, and access to climate change information influence the level of adaptation. Let's look at the negative value of the regression coefficient for the age variable. It means that the younger the age of the small-scale fishers, the greater the adaptation efforts of small-scale fishers in facing climate change. This is because younger small-scale fishers are more open to accepting innovations for their adaptation efforts than older fishers. This follows research by [18], which states that the younger a person is, the more enthusiastic they are to want to know about things they don't know yet, so they will try to be quicker in adopting innovation so that it is easier to adapt to the impact of climate change.

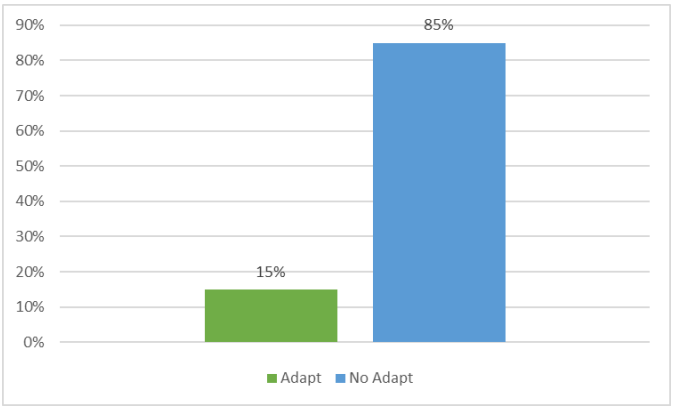


Fig. 3. Level of adaptation of small-scale fishers

The coefficient value for the education variable is positive (Table 2), which means that every increase in the education level of small-scale fishers increases the adaptation level index of small-scale fishers in the Bengkulu coastal area. The longer the education required by small-scale fishers, the greater the adaptation efforts of small-scale fishers in facing climate change. However, based on research results, most small-scale fishers in the coastal areas of Bengkulu have only studied up to elementary school (6 years). This is due to a lack of concern for education and the family's insufficient economic conditions to continue higher education. This is also directly proportional to research results, which state that only 15% of small-scale fishermen can adapt to the impacts of climate change because high levels of education determine the amount of effort required to adapt [19].

Table 2. Result estimation

Variable	B	Std. Error	t	Sig.
Constant	0.313	0.134	2.332	0.022
Age	-0.003	0.001	-1.763	0.081*
Formal education	0.010	0.005	1.985	0.050*
Fishing experience	0.001	0.001	0.928	0.356
Household size	0.005	0.007	0.697	0.488
Perception of climate change impacts	-0.003	0.002	-1.127	0.263
Group membership	0.090	0.021	4.314	0.000*
Access to climate change information	0.141	0.034	4.179	0.000*

Source: Primary data is processed, 2024
*Significant at α 10%

The coefficient value for the variable for participation in small-scale fisher's organizations is positive, which means that every small-scale fishers who participates in the organization can increase the adaptation level index of small-scale fishers in the coastal area of Bengkulu by 0.09, provided that the other independent variables have a fixed value. This means small-scale fishers who participate in the organization have a more fantastic opportunity to adapt to climate change's impacts than small-scale fishers who do not. The variable access to climate information also significantly affects the adaptation efforts of small-scale fishers in facing climate change. This means that small-scale fishers with access to climate information have a more significant opportunity to adapt to climate change than small-scale fishers without [20]. Small-scale fishers usually find this climate information via television, radio, and smartphones.

Overall, variables such as age, formal education, fishing experience, household size, perception of climate change impacts, group membership, and access to climate change information simultaneously (sig < α, 0.000 < 0.05) had significant effects on the climate change adaptation with a determinant coefficient of 30.4%

4 Conclusion

All small-scale fishers within the coastal regions of Bengkulu, Indonesia, see climate alter hurts capture fisheries businesses. In any case, what is astounding is that the level of adjustment carried out by small-scale fishers within the coastal areas of Bengkulu facing climate change should still be higher. There's a need for outreach from the government and related parties to small-scale fishers to extend information about mitigation and adjustment methodologies to the impacts of climate change. Variables that essentially impact the adjustment of small-scale fishers within the coastal regions of Bengkulu to climate change are age, instruction, cooperation in fisher's organizations, and getting to climate data. There should be mindfulness among small-scale fishers to form the most significant utilization of fisher's organizations and get to climate data to accommodate their endeavors to adjust to climate change.

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