Perceptions and local adaptation strategies to climate change of marine capture fishermen in Bengkulu Province, Indonesia

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Abstract. Adaptation is a key strategy to reduce the severe impacts of climate change on the fishery. Adaptation strategies are unlikely to be effective without an understanding of the fishermen’s perception on climate change. This paper explores fishermen’s knowledge on climate change perceptions and their climate change adaptation in response to the perceived impacts of climate change. A survey by interviewing randomly selected 90 marine capture fishermen was conducted in Bengkulu from March to June 2018. The results indicate that most fishermen understand climate change as a change of east and west monsoon that directly affect their fishing activities. In terms of climate change defined as a continuous change of temperature, humidity, and rainfall, most fishermen have no sufficient knowledge on climate change. The important adaptation strategies include diversification of household economic activities, augmenting of fishing gear, change the fishing ground, mobilization of family members to work, and fishing time adjustment.

1. Introduction

Climate change has serious impacts on coastal areas and considered the most vulnerable area affected by global warming as an accumulation of land and ocean influences. The capacity of households to adapt to the influence of climate change that affects households’ resources and resilience is uncertain due to poor socio-economic conditions [1]. Therefore, adaptation strategies are crucial for the local communities to cope with extreme weather conditions and associated climatic variations [2]. The strategies are, however, unlikely to be effective without an understanding of the fishermen perceptions on climate change. Perception and adaptation strategies are two key components of the adaptation process [3]. Adaptation is a process that determines how a strategy aimed at pressing, adapting, and being able to take advantage of the impacts of a climate event is expanded, developed, and implemented [4]. The adaptation capacity is highly dependent on how fishermen prepare for climate change. The fishermen’s perceptions of climate change are very important because these perceptions form the readiness or behavior of fishermen to build adaptation strategies and marine capture adjustments.
Many efforts have been made by Indonesia fishermen to cope with climate change. Fishermen have undertaken various strategies of physical adaptation, socio-economic adaptation, and human resources adaptation through a proactive and reactive approach. Physical adaptation strategy can be done with a proactive approach such as planting trees that directly withstand sea level rise, large wave, and rob, while reactive approach such as managing catching seasons and improving coral reefs managements. The socio-economic adaptation strategy with a proactive approach through the use of biotechnology in the field of cultivation of crops that will improve the economic welfare of coastal communities and reactive approaches that coastal communities move to other livelihoods that likely will not be affected by climate change. Adaptation strategy of human resources can be done by post-harvest management that is by paying attention to fishing on board until the fish is ready to be further processed or marketed, double income pattern aimed to get alternative income and conduct business activities outside fishery [5].

Bengkulu Province, situated in the West Coast of Sumatera, with 525 km coastline, facing the Indonesian Ocean. The coastal area consists of narrow plain, directly bordered with the steep slope of west facing the Bukit Barisan. Bengkulu Province is one of the disaster-prone area caused by weather/climate (hydrometeorology cycle) causing a flood, landslide, bad weather, tornado, drought, and others. Such a condition makes this province vulnerable to climate change. For example, two islands in North Bengkulu Regency, namely Bangkai Island and Pulau Satu sank due to rising sea levels, while the island of Enggano has narrowed [6]. This study focuses on the perception of fishermen on climate change and adaptation strategies held by marine capture fishermen to reduce their livelihood vulnerability caused by climate change.

2. Methodology

2.1 Study area
In this study, data were collected from coastal areas of Bengkulu Province, including Bengkulu City, North Bengkulu Regency, and South Bengkulu Regency. Sites selection were done by using a purposive technique based on a number of fishermen population (more than 200 people) and the existence of fish auction in that area. The coastal area of Bengkulu Province located on the west coast of the Sumatera Island with a coastline of more than 525 km [7] (Figure 1).
2.2 Sampling, questionnaire, and data collection
In this study, the unit of analysis was the household and the head of marine capture fishermen as the key informant. The method used in determining the respondents is by simple random sampling with a total of 90 fishermen were selected. The questionnaire was carefully designed to get information about the impact of climate change, on livelihoods, perceptions of changes in various climatic variables, and response strategies. Perceptions of change in various climatic variables were collected using a 5-point Likert scale. In the case of adaptation strategies, the respondents were asked about their range of practices. An adaptation strategy based on the experience and knowledge of the fisherman.

2.3 Data analysis
The fishermen perception of climate change is measured by a score ranging from 1 to 5. To get the fishermen perception of climate change, categorization is done based on the score obtained by Sturgess formula [8]. The climate change adaptation strategy is examined from adaptation strategies that have been done by fishermen in the context of adjustments to climate change in the fishing business. To analyze the correlation between fishermen perception and adaptation of climate change, correlation analysis is used in this correlation Spearman Rank analysis.

3. Marine capture fishermen profile of Bengkulu Province
Characteristics of respondents in this study are divided into five characters. Description of the characteristics of respondents as follows:

| Table 1. Characteristics of marine capture fishermen in Bengkulu Province, Indonesia |
|-------------------------------|-----------------|----------|
| No. | Categories | ∑ (person) | %       |
|----------|------------|------------|---------|
| 1. | Age | | |
| | < 15 | 1 | 1.11 |
| | 15 – 64 | 89 | 98.89 |
| 2. | Side Jobs | | |
| | Don’t have side job | 53 | 58.89 |
| | Farmer | 24 | 26.67 |
| | Non-Farmer | 13 | 14.44 |
| 3. | Formal education | | |
| | ≤ 6 years | 57 | 63.33 |
| | 7 – 9 years | 17 | 18.89 |
| | 10 – 12 years | 10 | 11.11 |
| | > 12 years | 6 | 6.67 |
| 4. | Number of family dependents | | |
| | 0 – 2 (low) | 23 | 25.56 |
| | 3 – 5 (medium) | 62 | 68.89 |
| | 6 – 8 (high) | 5 | 5.54 |
| 5. | Experience as a fisherman | | |
| | 3 – 11 | 22 | 24.44 |
| | 12 – 20 | 40 | 44.44 |
| | 21 - 30 | 28 | 31.12 |

Source: Primer Data, 2018

3.1 Age
Age is one of the factors that support the fishing effort because in productive age one can do the job with maximal and productive age based on Central Bureau of Statistics data ranging from 15 - 64 years. In the Coastal area of Bengkulu Province, most marine capture fishermen are at the productive age ranging from 15 to 64 years old. Work as a fisherman requires a strong physical because dealing with a natural environment that could not be predicted risks.
3.2 Side jobs
Uncertainty in fishing effort makes fishermen need to find additional income if bad season happen. The data in the field show that the Bengkulu City and South Bengkulu Regency, most fishermen have no a side job, while most fishermen in North Bengkulu Regency, have a side job as oil palm farmer. This is because the neighboring coastal areas of this location are available sleeping land that is potential for oil palm plantation.

3.3 Formal education
Formal education cost is relatively expensive for poor fishermen, make it as obstacles for them. Table 1 explains that the formal education of marine capture fishermen in Bengkulu province is low and most of them are not graduated for elementary school. Structural poverty makes fishermen unable to pursue a proper and adequate formal education due to limited income. This phenomenon continues to occur for generations in the family.

3.4 Number of Family Dependents
Burden of the family dependence of each fisherman will affect their needs and welfare. The number of dependents of the family is all people who are in a family who become dependents of the head of the family. The results showed that a number of dependents of fishermen family dependents in the coastal region of Bengkulu Province ranged from 0 - 8 people. Fishermen can utilize a labor in the family to carry out fishing business and for obtaining income from outside the fishing business.

3.5 Experience as a fisherman
Experience in fishing effort is a learning process for fishermen in managing their business because the experience period will have an effect on managing the business. Table 1 indicated that the majority of fishermen have experience ranging from 12 to 20 years. Due to its geographical conditions, which is a coastal area, make most in this area become a fisherman. The distribution of fishermen based on their experience can be seen in Table 1 which is divided into three groups namely, the first group is fishery fishermen with experience ranging from 3 to 11 years, the second group have experience range of 12 - 20 years and the last group of fishermen has the longest experience, ranging between 21 to 30 years.

4. Results and discussions
The results of the marine capture fishermen study are presented in three parts: climate change perceptions, climate change adaptation, and the correlation between climate change perception and adaptation.

4.1 Climate change perceptions
The perception of marine capture fishermen on climate change is the interpretation of fishermen to the ecological changes that occur due to climate change. Perception measurements seen through statements containing cognitive components include seven climate change indicators developed with 17 statements about the experience and knowledge of respondents on climate change. The results show that most of marine capture fishermen have a poor understanding of the current climate change (Table 2). Fishermen perceive that climate change is only a change between east and west monsoon, while for climate change indicator covering temperature change, rainfall and others they are not understood.

| Climate change perception               | ∑ (person) | %      |
|----------------------------------------|------------|--------|
| Understand (122 – 147)                 | 17         | 18.89  |
| Little understood (97 – 121)           | 40         | 44.44  |
| Do not understand (73 – 96)            | 33         | 36.67  |
| ∑                                      | 90         | 100    |

Source: Primary Data is processed, 2018
Figure 2. Respondent perception based on climate change indicators

Figure 2 presents the percentage of fishermen based on their understanding of climate change indicators presented in this study. Climate change indicators include: increased intensity of occurrence of rob and high waves, increased global temperatures, increased extreme weather events, changes/shifts in direction and strength of currents, changes in intensity/rainfall, sea level rise, changes/shifts in the rainy and dry seasons. Figure 2 also shows that fishermen understand the most about the changing times of the rainy and dry seasons relating to the winds of the east and west monsoons, which greatly affect fishing activities in running their fishing businesses.

4.2 Local climate change adaptation

The adaptation strategy approach used in this study is an approach introduced by Barlett in Cahyadi [9]. Through this approach, it will be understood how fishermen apply the adaptation strategies and how the patterns of adaptation made. The climate change adaptation consists of 11 adaptation strategies with different percentage of respondents per adaptation to climate change (Figure 3). Figure 3 shows that climate change adaptation of fishermen in Bengkulu Province includes: change the fishing ground, fishing time adjustment, diversification of fishing gear, diversification of economic activity, and seeking information about climate change. More climate change adaptation strategies show the increasing of understanding and level of knowledge of fishermen to climate change.

A lot of adaptation by marine capture fishermen are to change fishing ground and fishing time adjustment that is equal to 86.67%. This adaptation relies solely on the instinct and experience of detecting the area that many fish estimate. This results in energy inefficiency, time wastage, and low catch. The catching area is usually 5 to 10 miles from the seashore. It could not exceed the distance because of their boat size and limited capital for fuel. To get a maximum catch, fishermen feel the need to increase the number of fishing gear. In general, fishermen in Bengkulu are small fishermen. Fishermen make fish captures with simple technology and based on their economic conditions. The standard fishing gear owned is a fishing line and fishing nets. In addition, the fishermen also combine with fishing gear such as Bubu¹, and shrimp/lobster nets. The use of fishing gear is tailored to the interests of fishermen.

¹ Bubu is a type of fishing gear in the form of traps made of bamboo and iron wire which is usually located in the coral reef area. Bubu placement is done in the area around the reef so that Bubu is not swept away and reef fish stuck into the trap. Some expensive fish usually hide a lot in the reef area.
Figure 3. Percentage of respondents based on climate change adaptation

Table 3. Correlation between perceptions and local climate change adaptation

|                  | X                   | Y                   |
|------------------|---------------------|---------------------|
| Spearman's rho   | Correlation Coefficient | Correlation Coefficient |
|                  | 1.000               | .232*               |
| Sig. (2-tailed)  | .028                | .028                |
| N                | 90                  | 90                  |
|                  | Correlation Coefficient | Correlation Coefficient |
|                  | .232*               | 1.000               |
| Sig. (2-tailed)  | .028                | .028                |
| N                | 90                  | 90                  |

* Correlation is significant at the 0.05 level (2-tailed).

4.3 The correlation between perceptions and climate change adaptation

The perception of fishermen on climate change is very important because perceptions form the readiness of fishermen to adapt to climate change and adjustments to their capture fisheries business. The relationship between perceptions of fishermen on climate change and climate change adaptation can be seen in Table 3. Spearman's rho r value is 0.232 with the sig. (2-tailed) of 0.028 or less than 0.05 so it can be decided that between the perception of fishermen and climate change adaptation is significant. Fishermen as the main actors in capture fishing business should have known about climate change in the sense of how fishermen perceived the climate change. Because perceptions about climate change shape the readiness of fishermen to adapt. The perception of climate change of these fishermen was formed based on their beliefs, knowledge, and experiences of climate change [10] and from this perception, they have adopted new behaviors or innovative practical approaches [11].

5. Conclusions

Marine capture fishermen in Bengkulu Province are less aware of the current climate change. Fishermen perceive that climate change is only a change between east monsoon and west monsoon, while for climate change indicator covering temperature change, rainfall and others are not understood by fishermen. To reduce the impacts of climate change, fishermen have made various climate change adaptations, including changing fishing grounds, harnessing fishing time, diversifying fishing gear, and diversifying economic activities. There is a correlation between perceptions’ fishermen of climate
change and local climate change adaptation. This indicates that the more understanding of the fishermen about climate change that occurs will be more adaptation made by fishermen in Bengkulu Province.

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