

Local Knowledge of Climate Change: Insights From Traditional Fishermen in Lampung Bay, Indonesia

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Abstract

This study aims to assess the knowledge and perceptions of traditional Bagan fishermen operating in Lampung Bay regarding the dynamics of climate change. Lampung Bay serves as a center of fisheries activity, making coastal communities, including traditional Bagan fishermen, highly dependent on fisheries for their livelihoods. However, this area is highly vulnerable and heavily affected by climate change. This study employs a qualitative approach, utilizing data collected through in-depth interviews and participatory observations involving the traditional Bagan fishermen community, formal institutions specifically the Head of Kota Karang urban village, Maritime Affairs and Fisheries Agency of Lampung, and Agency for Meteorology, Climatology, and Geophysics of the Republic of Indonesia (BMKG) and informal institutions socio-economic institutions consisting of fishery product processing entrepreneurs, *pelele* (fish trader), *konca* (captain) and *pelimelime* (crew). The results indicate that despite being aware of the impacts of climate change on Lampung Bay, most fishing communities employ diverse adaptation strategies to overcome their inherent limitations. A critical determinant in constructing social resilience is the optimization of informal institutions. Based on these results, it is recommended to implement an adaptive climate change impact management policy with a participatory approach.

Keywords

Bagan; climate change; Lampung Bay; perception; social resilience

Introduction

Indonesia has a significant potential for capture fisheries estimated at 12.5 million tons; however, the contribution of this sector to the Indonesian economy remains marginal, at approximately 2% (Anna, 2019). It is estimated that there were 960,000 capture fishermen in Indonesia in 2016 (Stacey et al., 2021), with 90% of them being small-scale fishermen (Ayunda et al., 2018). In Lampung Province in 2020, at least 28,540 capture fishermen were operating in marine waters. The fisheries sector is widely recognized as a source of food diversity, food security, and poverty alleviation. However, the fisheries sector continues to face challenges and threats posed by the ongoing negative impacts of climate change. These negative impacts can also disrupt the ecological functioning of marine ecosystems, driving changes in fish species' distributions and body sizes, which directly affect marine fisheries production (Cappa et al., 2024). Climate change poses significant challenges to marine ecosystems and fisheries, requiring effective management and adaptive strategies. At the same time, marine fisheries exacerbate climate change by emitting greenhouse gases through fuel combustion and electricity consumption (Y. Xu et al., 2024).

The small-scale fisheries sector is directly impacted by climate change. Studies focusing on small-scale fisheries are necessary due to the high exposure of the fishing community to climate change. Small-scale fisheries offer several advantages, including lower carbon footprints and lower capital requirements compared to industrial-scale fisheries. However, small-scale fisheries are constrained by limited access to environmental resources and high exposure to natural phenomena. On the other hand, small-scale fisheries play a role in ensuring protein security and food security within coastal communities that are highly vulnerable to climate change (Saha et al., 2024; Shah et al., 2025; Zhang et al., 2024).

Fishermen operating within Lampung Bay encounter multifaceted environmental, social, and economic vulnerabilities. For communities reliant on marine resources, these challenges manifest as declines in biodiversity and productivity, which will affect the distribution and abundance of fish species and reduce fishermen's catches (du Pontavice et al., 2020; Intergovernmental Panel on Climate Change, 2023; Rankoana, 2018). Moreover, the impact of climate change exacerbates the vulnerability of coastal communities, including their access to food, energy, health facilities, and services. Furthermore, Chen et al. (2020) demonstrated that fishermen are highly vulnerable to climate change, a vulnerability linked to demographic traits, particularly advanced age and lower education.

This condition causes fishermen to face socio-economic problems in meeting their families' needs because the fishing season varies from year to year. This makes traditional fishing communities implement and develop social, economic, and ecological adaptation strategies. Fishermen have a pattern of adaptation to climate change. A study conducted in coastal communities by Chen et al. found that fishermen are highly vulnerable to climate change, with characteristics such as advanced age and low levels of education. In dealing with climate change, communities engage in adaptation practices such as developing integrated fisheries-tourism activities (Susilo et al., 2021) and internal migration (Alam et al., 2017; Ayebe-Karlsson et al., 2016; Bernzen et al., 2019).

Several previous studies have examined this, giving rise to perceptions and knowledge systems resulting from interactions with the socio-ecological environment. The study of farmers' perceptions and knowledge is the basis for their adaptation actions to facilitate

sustainable agricultural practices (Foguesatto et al., 2019; Jezeer et al., 2019; Mahmood et al., 2021). Several studies have been published on this topic, such as a study of the perceptions of irrigated rice farmers based on spatial variations (Arifah et al., 2022a; Arifah et al., 2022b), and the perceptions of coffee farmers through the construction of coffee farmers' knowledge about climate change, which is the result of learning from village elders (Arham et al., 2024).

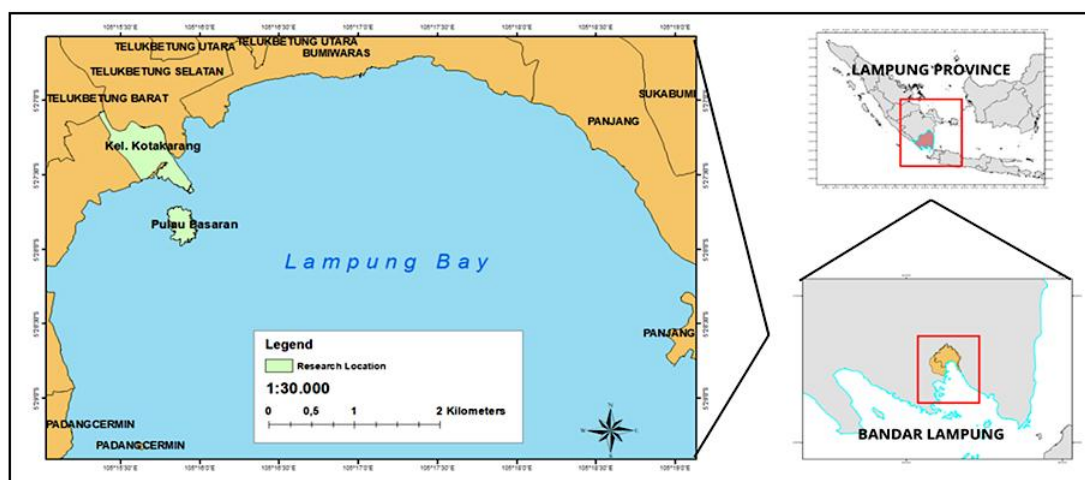
Furthermore, fishing communities with a good understanding and perception of climate change tend to choose the right adaptation strategies (Ayisi et al., 2024; Mason et al., 2024; Mubai et al., 2023). Furthermore, with local understanding through the preservation of ancestral knowledge, cooperation among communities is beneficial for making decisions about adaptation strategies to the impacts of climate change (Parra & Jensen, 2025). The challenges and threats posed by climate change, especially those affecting marine and fisheries ecosystems, require an effective and adaptive management system (Y. Xu et al., 2024). Therefore, adaptation to the impacts of climate change is needed to reduce the vulnerability of small-scale fisheries' livelihood systems.

However, among previous studies, this study's advantage lies in its analysis of the knowledge and perceptions of Bagan fishermen, which also highlights the importance of involving institutional actors, including formal and informal institutions, to draw meaningful conclusions. Therefore, formulating adequate capture fisheries management policies is necessary not only for fishermen's perceptions but also for understanding the roles of institutional actors (formal and informal) as a whole and for an integrated understanding of the reality of climate change. This study aims to analyze the understanding, perceptions, and adaptation patterns of traditional fishermen active in Lampung Bay.

Research methods

This study was conducted in the Kota Karang urban village (*kelurahan*) in the Telukbetung Timur District (*kecamatan*) (see Figure 1). This location was purposively selected considering that the majority of traditional Bagan fishermen reside in Lampung Bay. Kota Karang urban village serves as a primary hub for fisheries activities in Lampung Province, driven by the anchovy processing industry, reaching both domestic and international markets.

Figure 1: Map of the Study Region



Note: The base map was adapted from Google Earth data (© Google Earth contributor) and modified for

analytical clarity. The inset map was adapted from openly licensed materials and redrawn by the author to ensure consistency of scale, orientation, and visual style. This image is intended to provide geographic orientation to the study site, not cartographic accuracy.

Traditional fishers in this area rely on traditional fishing gear known locally as Bagan. In 2024, the presence of this Bagan fishing gear operating in the waters of Lampung Bay remains highly prevalent compared to other fishing gear, with a minimum of 96 active Bagan units. Each Bagan is operated by a single fisherman and assisted by a motorboat to tow the Bagan structure to reach wider fishing grounds.

This study employs a qualitative method to explore the meanings, interpretations, and understandings of climate change events, with a particular focus on perceived impacts among Bagan fishers active in Lampung Bay. A qualitative approach allows exploration of the experiences, perspectives, and meanings inherent in the adaptation practices undertaken. In qualitative studies, data are generally collected using interview and observation techniques (Creswell & Creswell, 2018; Hammersley & Atkinson, 2019).

Data were collected through in-depth interviews with fishermen selected via snowball sampling, including those who have fished for more than a decade, to identify changes that have occurred in recent years. A total of 57 fishermen informants, consisting of 12 patron fishermen and 45 client fishermen, were interviewed to obtain saturated data, as no new information emerged from subsequent interviews (Corbin & Strauss, 1990).

Interviews were conducted in Indonesian (Bahasa Indonesia) using a list of open-ended questions to allow fishermen to convey information freely and to avoid researcher dominance. In addition, eight additional informants were specifically selected to support the data obtained by involving informal institutions such as one *pelele* (fish trader), one fishery product-processing entrepreneur, *konca* (motorboat captain), and one *pelimelime* (motorboat crew), and formal institutions such as the Head of Kota Karang urban village, Maritime Affairs and Fisheries Agency of Lampung, and Agency for Meteorology, Climatology, and Geophysics of the Republic of Indonesia (BMKG) (Table 1).

Table 1: Biographical Details of Sampling

Informant	Number of informants	Age group	Education level
Patron (Juragan)	12	40–60	Illiterate to 10+2 Indonesian standard
Klien (Sawi)	45	40–55	Illiterate to 10+2 Indonesian standard
Motorboat Captain (Konca)	1	50–60	Illiterate
Motorboat Crew (Pelimelime)	1	45–55	Illiterate
Government Institution	4	45–60	Undergraduate and Postgraduate
Fishery Product Processing Entrepreneurs	1	55–65	10+2 Indonesian standard
Fish trader (Pelele)	1	40–55	10+2 Indonesian standard

Primary data collection in this study was conducted through participant observation and in-depth interviews with research subjects. Literature reviews were also conducted to support the validity of the collected data, particularly by comparing the results with those of previous

studies and other related documents. In general, data collection was carried out from 10:00 to 14:00, which is the best time for heads of families who work as fishermen. Each data collection lasted for 40–60 minutes per questionnaire. In-depth interviews allow researchers to gain deeper insight into thoughts, feelings, and motivations for seeking alternatives (Z. Xu et al., 2024). Meanwhile, participatory observation was also used to directly observe the practices and patterns of adaptation employed by fishing communities in response to climate change. Through these observations, fishermen's social interactions, family dynamics, and local knowledge within the context of maritime culture, which influences fishing activities in Lampung Bay, were examined.

Data analysis was conducted using a case study approach, in which qualitative data from in-depth interviews and participant observations were systematically evaluated to identify emerging patterns, themes, and meanings, thereby better understanding Bagan fishers' perceptions of climate change. Furthermore, a comparative analysis was performed to triangulate the fishermen's perspective on formal and informal institutions.

The researcher also asked for the informant's prior approval before conducting the interview and provided information about the study's intent, purpose, and benefits. Participation was entirely voluntary, and informants' identities and information were kept confidential and used solely for academic purposes. The fieldwork for this study was conducted with a strong emphasis on the ethical protection of human subjects. Before commencing interviews, the research secured Ethics Approval (1871/070/05224/SKP/III.16/VI/2024) from the Bandar Lampung City Government, Lampung Province.

Results

Bagan in Lampung bay

Historically, the coastal area of Lampung Bay has been recognized as a fishing area dominated by traditional fishermen, particularly Bagan fishing gear. The primary target of this gear is small pelagic fish such as anchovies (*Stolephorus* sp.). Bagan in Lampung Bay is constructed from ± 30 plastic jerrycans for floating and is towed by motorboats to reach wider fishing grounds. Bagan fishermen face a distinct fishing season lasting approximately four months a year.

Figure 2: Construction of Bagan in Lampung Bay



Note: The photo is original documentation by the researcher.

The development of marine fisheries production and value in Lampung Province is shown in Table 2. Pelagic fish dominate the potential of fish resources in the study location, such as Lampung Province. Marine capture fisheries production in Lampung Province fluctuated between 2017 and 2020, with an overall decline from 172,277 tons in 2017 to 137,404 tons in 2020.

Table 2: Production and Production Value of Capture Fisheries in Lampung Province, 2017–2020

Year	Marine Capture Fisheries	
	Volume (tons)	Value (000 IDR)
2017	172,277	5,587,514,341
2018	136,750	4,938,457,056
2019	155,552	5,029,199,582
2020	137,404	4,275,360,629

Note: BPS-Statistics of Bandar Lampung Municipality (2021); 1 USD ≈ IDR 14,582

Meanwhile, capture fisheries in Kota Karang urban village, Bandar Lampung City, are dominated by small-scale fisheries, with anchovies as the main catch. Based on marine fish production data by type in Bandar Lampung City, anchovy production increased from 251 tons in 2019 to 257.36 tons in 2020 and 425 tons in 2021 (BPS-Statistics of Bandar Lampung Municipality, 2021, 2022). The two different types of anchovies caught in Lampung Bay are white anchovy and brown anchovy (Figure 3).

Figure 3: Types of Anchovies Caught by Bagan Fishermen Operating in Lampung Bay



Note: The photo is original documentation by the researcher.

Bagan fishermen operate under a one-day fishing system, departing around 14:00 via motorboat assisted by *konca* (captain) and *pelimelime* (crew) and returning to land by 6:00 the following morning. Before climate change hit the waters of Lampung Bay, Bagan fishermen went to sea almost every day. This contrasts with recent conditions: despite the peak fishing season, the fishermen rarely go to sea, typically only 5–7 days per month due to fish scarcity. They communicate with other fishermen to gather information about fish locations.

Characteristics of knowledge regarding climate change

The manifestations of climate change are evident in the experiences of fishermen during fishing activities, from departure to arrival at the fishing location and finally to their return to the port. Indicators of change, such as more extreme weather that alters ocean currents and storm patterns, make water conditions increasingly difficult to predict. This information is implied from the fishermen's statements as stated below:

Currently, the condition of fish in the sea is difficult to predict due to ocean currents. When arriving at the fishing location, the sea waves are calm, but in the water column the current is strong, causing schools of fish to be unable to gather under the Bagan. This strong ocean current is also dangerous for fishermen because it has the potential to drag the fishermen's nets and Bagan. Storm winds also often come suddenly; usually, when we go to sea, the weather is sunny, but when we arrive in the middle of the sea, the weather conditions can change drastically, accompanied by storms.

(MJ, 55 Years, Bagan Fisherman)

The increasing intensity of climate events has led to tidal flooding and extreme weather in recent years. The fishing community increasingly feels this because most of them live near the coast and build houses above sea level, making them highly vulnerable to exposure. This information is implied from the fishermen's statements, as stated below:

The threat of tidal flooding occurs almost every year. In addition to flooding, storm intensity is also quite high, known to the community as

whirlwinds. The impact causes economic losses to our income because we cannot go to sea with unfavorable weather conditions.

(MU, 42 Years, Bagan Fisherman)

The Bagan fishing community also obtains information about climate change from external sources, such as communication media (TV, Radio, Social Media) and weather applications. This was stated by the fishermen as follows:

I get information about extreme weather from television and radio. When BMKG announces bad weather, I immediately switch to the Windy app on my cellphone. Generally, the information is the same, so when the weather is bad, most fishermen decide to postpone going to sea.

(JM, 40 years old, Bagan Fisherman)

In addition to the fishermen, the konca (captain) and pelimlime (crew) also shared their experiences while interacting with the Bagan fishermen. This motorboat transports the Bagan fishermen to the fishing grounds by towing the Bagan. Climate change can also be understood through the perception of konca and pelimlime as informal institutions. This information is implied from their statements, as stated below:

The condition of the current and ocean waves is increasingly difficult to predict. Fishermen often ask to move their nets to other fishing locations two to three times in one fishing trip. This is due to fluctuations in ocean currents that are strong in the water column but calm on the surface, which affect the distribution of fish that can gather under the nets.

(AR, 57 years old, Konca)

As an informal economic institution, the pelele conducts direct, cash-based transactions onboard each Bagan to purchase fish. The pelele group also experienced more intense extreme weather and storms in Lampung Bay over the last decade. This was stated by a pelele:

I will visit every Bagan that successfully catches fish. In recent years, the condition of the waters of Lampung Bay has been very extreme. The weather conditions are difficult to predict, so sometimes I visit the fishermen's Bagan but can't buy any fish because the fishermen don't get to sell the fish they catch.

(RL, 44 years old, Pelele)

The phenomenon of climate change in Lampung Bay waters is also confirmed by other actors, namely formal institutions from government stakeholders. This information is implied from the statements of stakeholders who were successfully interviewed, as listed below:

Climate change that occurs in Kota Karang has a negative impact on coastal communities, especially Bagan fishermen. Sometimes the fishermen go to sea, but not in accordance with the capital spent to go to sea. It hampers the economic activities of coastal communities.

(BH, 54 years old, Head of Kota Karang urban village)

In 2023, there was an El Niño condition until October. The impact was that the rainy season in Bandar Lampung only started in November 2023, whereas the rainy season should have started in September. This condition

indicates that there has been climate change, where it occurs sooner or later than normal conditions depending on current global climate conditions.

(NK, 53 years old, Agency for Meteorology, Climatology, and Geophysics of the Republic of Indonesia)

In recent years, most fishermen have been on land because the condition of the waters of Lampung Bay has experienced climate change, which has caused the distribution of fish in the sea to become more difficult for the fishing community to predict.

(IW, 51 years old, Fisheries Extension Officer, Maritime Affairs and Fisheries Agency of Lampung)

The results of this study indicate that both fishing communities and formal and informal institutions have the same knowledge and understanding of climate change that has occurred in Lampung Bay. Despite limited scientific understanding of climate change, extreme weather events at sea affect the fisheries business. To operate, fishermen employ several adaptation strategies.

Table 3: Adaptation Strategies of Bagan Fishermen in Facing the Impacts of Climate Change

Adaptation	Adaptation strategy
Environmental Adaptation	Using Windy application technology (weather detection application) to detect wind speed so that when the application is applied there is a threat of a storm at sea, fishermen decide not to go to sea.
Social/Behavioral Adaptation	a. Fishermen explore new fishing areas b. Fishermen exchange information related to their experiences at sea and sea conditions through mobile phone communication (Internet)

Fishermen's perceptions of the impacts of climate change

The results of interviews with Bagan fishermen indicated that climate change has negatively affected their fishing activities and is expected to continue to do so. Perceptions of climate change impacts at the study location were grouped into three categories: physical and ecological impacts, socio-economic impacts, and impacts on knowledge and belief systems. Bagan fishermen have felt the impact of climate change.

First, regarding the physical and ecological impacts of climate change, such as increased rainfall intensity and wind, fishermen are highly exposed. Most fishermen's settlements are built at sea level, so the fishing community is directly exposed to the coastal and marine environment. This damages fishermen's houses.

The house collapsed. It was no longer strong enough to withstand the impact of extreme weather because it was not equipped with a wave-retaining wall. There have been many incidents of houses being damaged in the fishermen's settlements here due to extreme weather, including storms.

(SN, 47 years old, Bagan Fisherman)

Ecological impacts are felt by Bagan fishermen. The anchovy fishery in Lampung Bay is

severely affected, and fishermen have to go farther out to fish. The damage to the ecological balance of marine waters is also marked by changes in the aquatic environment. In interviews, fishermen shared their experiences.

Now we look for fish farther out, depending on schools of fish. The location is also uncertain and often moves depending on the condition of the sea waters.

(BN, 56 years old, Bagan Fisherman)

Anchovies are increasingly difficult to find even though it is currently the peak fishing season. However, we go out to sea and do not get any anchovies at all. Maybe the anchovies have moved to another place.

(AR, 40 years old, Bagan Fisherman)

Second, the fishing community perceives that climate change also affects households' social and economic conditions by reducing their income. Meanwhile, Fish processors on Pasaran Island also reported that climate change has a significant impact on their fish-processing business. Climate change makes it increasingly difficult for fishermen to catch fish; when they go to sea, they are not certain to catch any, so fishing activities are currently full of uncertainty. Based on the statements of informants, fishermen tell their experiences as follows:

The influence of the weather greatly affects the condition of the fish in the sea; currently, for almost the last 2 months, none of us fishermen have gone to sea. Because of this condition, we fishermen are more on land while waiting for information from other fishermen.

(MS, 43 years old, Bagan Fisherman)

The declining fish catch among fishermen was also conveyed by Pelele, who interacted directly with Bagan fishermen to buy their catch. Based on an interview with Pelele, he conveyed his experience as follows.

In one night, we can get 2 to 3 baskets, and we are grateful. Even then, we have almost gone around to every fisherman's Bagan. The condition of the sea waters, affected by environmental changes, has made it difficult for fishermen to catch fish.

(EN, 41 years old, Pelele)

In line with these conditions, fish processing businesses on Pasaran Island also experienced difficulties in obtaining raw fish materials from fishermen. This disrupted fish processing activities. The results of observations of fish processing activities on Pasaran Island showed that many fish-drying locations were not operating due to a lack of raw anchovy material from fishermen. Based on interviews with informants, salted fish processors shared their experiences as follows.

My fish drying business has barely been operating for the past month. It is very different from the previous conditions; for example, when it stopped operating, it usually lasted only 1 to 2 days because raw fish materials are available year-round. Currently, our products are in high demand for delivery to Jakarta and its surroundings, but we cannot fulfill them because there is no fish stock from fishermen at all. I think climate change is the cause.

(DK, 57 Years Old, Fish Processing Entrepreneur)

Third, climate change affects the knowledge and belief systems of fishermen who have been engaged in fishing activities for years. Culturally, Bagan fishermen have a very strong bond of trust rooted in a set of beliefs and knowledge that guides their fishing activities. Naturally, the fishing community understands phenomena related to the sea. Knowledge of fishing activities is rooted in fishermen's thinking, shaped by their long-standing interaction with the sea.

Based on interviews with experienced Bagan fishermen, information was obtained that:

In the past, we used a benchmark to go to sea and predict the fishing season based on the calendar and month; for example, when an odd-numbered date came, we decided not to go to sea and rested at home or repaired the Bagan. We were sure and believed that there were good days to go to sea; the fortune of going to sea depended on the day and month.

(BR, 60 Years, Bagan Fisherman)

We do not fish on Islamic celebration days, such as when entering the month of the Prophet Muhammad's Birthday; there was a belief that this was done as a form of gratitude for the sea sustenance given by the Almighty Creator so that later there would be more fish in the sea.

(SD, 56 years old, Bagan Fisherman)

If the current condition is no longer valid, the system of knowledge that is understood has shifted, so predictions often deviate from the usual. Therefore, the benchmark for the fishing season can no longer be a guideline, so when there is information that fishermen get fish, we are also prepared to go to sea.

(JM, 50 years old, Bagan Fisherman)

The guidelines that have been the beliefs and knowledge born from interactions with the sea have recently begun to fade because they realize that even though they have followed the advice and are guided by the beliefs of their ancestors and avoided various taboos before going to sea, it will not have a significant impact on their livelihoods as fishermen. The phenomenon of climate change seems beyond their reach, and they lack knowledge of what is currently understood.

Social resilience as a result of successful adaptation

Climate change is felt significantly by the Bagan fishermen, particularly in decreased fish catches and increased temperatures, rainfall, and wind, which affect fishing operations. The results of the study categorized resilience into three categories: (1) social resilience as an opportunity for disturbances, (2) social resilience as a process of resilience from threats of disturbances and changes, and (3) social resilience as the development of the concept of capitals.

First, social resilience is an opportunity for disturbances. The increasingly unpredictable condition of the marine environment means that fishermen carry out fishing activities in groups to anticipate unexpected weather changes at sea and to unite views and experiences

to deal with changes in the marine environment and target fish.

I joined the Padaidi motorboat. There were 12 fishermen who also joined this motorboat group. When we were going to sea, we went together in groups to the fishing location.

(AC, 49 years old, Bagan Fisherman)

Fishermen have also realized that relying on marine resources is full of uncertainty, so some have developed other skills, such as carpentry, which can be used at times as off-fishing activities.

If I don't go to sea, I sometimes work in construction if I'm called. I also have skills in repairing generators, so I can help the family's finances if I don't go to sea. I even worked in a factory when the sea conditions were very bad.

(MZ, 43 years old, Bagan Fisherman)

Second, social resilience is a process of resilience to the threat of disruption and change. In the face of climate change, the adaptation process will continue, given the ongoing rate of change. There, a community is resilient if its social system can recover from the problems it faces, rather than focusing solely on climate-change-related shocks or changes. Some fishermen have updated their fishing technology by diversifying their fishing gear. Previously, the fishermen used a roller manually for hauling. However, this process is considered less suitable than using a generator for fishing recently. Adopting fishing technology can maximize their catch even during the lean season.

Now, most Bagan are equipped with generators, making it easier to lift fish that have gathered under the net.

(HM, 42 years old, Bagan Fisherman)

To facilitate the fishing process, Bagan fishermen also no longer use gasoline, which is very difficult for traditional fishermen to access.

I use a 5 kg gas cylinder as a substitute for fuel because it is difficult to obtain. The use of this gas cylinder is also cheaper and easier to obtain.

(BL, 47 years old, Bagan Fisherman)

Fishermen also strengthen social networks as one strategy to survive in the face of poverty. This social network is very useful for fishing communities, from supporting fishing activities to helping them overcome severe family economic turmoil.

If I am not at sea and need money to buy rice, I ask the boss for help first. I will pay later after I go back to sea and get the fish I caught.

(AR, 40 years old, Bagan Fisherman)

A very strong social network is evident in family relationships, such as patron-client ties, which are characterized by high mutual trust and solidarity. During the research, the repair of damaged jerrykan nets was photographed and carried out cooperatively by fishermen in groups of patrons or fellow fishermen on the same motorboat to minimize costs.

When there is damage, we help each other by working together to repair the net. Especially for fellow fishermen who are on the same motorboat.
(JU, 50 years old, Bagan Fisherman)

Therefore, the potential to develop social capital, such as high participation in groups, high mutual trust, and solidarity, and ease in carrying out activities collectively, is the main capital that is very effective in increasing the social resilience of the Bagan fishing community.

Third, social resilience is a development of the capital concepts. Based on capital assets, there are differences between fishermen in the patron and client categories. In the patron category, financial capital is a source of strength to face climate change variability. With adequate financial capital, this will align with owning more than one unit of fishing gear. This will certainly open up opportunities to increase income by deploying more fishing fleets to catch fish. This is different from client fishermen who do not have access to physical capital in the form of ownership of fishing gear.

Fishermen manage natural capital by chasing the fishing season and optimizing fishing trips. The fishermen adapt to climate change by chasing the fishing season further. They learn where they are likely to catch fish; they immediately prepare to go to sea. The fishermen also maximize fishing trips by catching non-target fish such as squid, mackerel, tuna, and skipjack tuna, which can later be sold in local markets around Bandar Lampung.

Physical capital consists of basic infrastructure and equipment that can produce goods or services, thereby fostering livelihood growth. Patron control assets in the form of physical facilities and infrastructure resources by owning fishing gear and a motorboat. This is different from client fishermen who do not have access to physical capital in the form of ownership of fishing gear.

Human capital refers to fishermen's ability to access resources that improve their livelihoods. Most fishermen have never received training, knowledge, or skills related to climate change mitigation. This low human capital is also evident in the average education level of fishermen, who are only elementary school graduates. This affects the absorption of information and understanding of climate change.

Discussion

The study aims to explore the knowledge and perceptions of Bagan fishermen regarding the impacts of climate change and their adaptation strategies. This study is limited to Bagan fishermen operating in Lampung Bay, and its discussion focuses on their perceptions of climate change and adaptation. Several previous studies have been conducted worldwide, demonstrating the relevance of local community perceptions and knowledge to climate change. Therefore, the local community knowledge system is greatly influenced by the pattern of human and natural interaction.

The interview results also showed that Bagan fishermen who had access to more external sources of information tended to have a higher level of knowledge about climate change. This is in line with a study by Putri et al. (2024) showing that internet access in rural and coastal areas affects lifestyles and adaptation practices. Previous research by Braga et al. (2022) used technology to share knowledge and facilitate communication between groups of fishermen in

the coastal lagoon of Rio de Aveiro, Portugal. Therefore, the impact of its use is significant. The use of mass media (TV, radio, and the internet) can play a crucial role in providing the public with information, especially on marine conservation topics such as marine protected areas, marine biodiversity, ocean conditions, and marine pollution (Thompson-Saud et al., 2018).

The impact of climate change has forced fishermen to understand the phenomenon. Climate change is recognized as one of the critical challenges facing humans today (Leal Filho et al., 2019). Several previous studies have stated that the challenges of climate change have negative impacts, including on the fisheries sector (Badjeck et al., 2010). Therefore, people seem to care more when they feel the impact of climate change (Azadi et al., 2019).

The results of the study show that the impacts of climate change experienced by fishermen also affect the sustainability of processing businesses on Pasaran Island. Fishermen must look for fish in other areas and go farther out to sea than before. This will have a direct impact on fishermen's income. Bagan fishermen, as producers, have experienced a decrease in anchovy production, but they have limited capital to search farther for fish. This is consistent with previous studies indicating that fisheries businesses and fishing communities experience various pressures due to past climate change. The impact will reduce income distribution due to reduced fisheries production and worsen national food insecurity (Mohammed & Uraguchi, 2013).

Climate change also affects the dried anchovy processing industry. Due to limited raw materials, many dried anchovy processing businesses are not operating, even though demand for this product is quite high. Loss of income from this processing industry results in job losses. Based on Mohammed and Uraguchi (2013), sea level rise is likely to negatively affect fisheries production (due to salinity pressure on fish stocks and their habitats) as well as fish landing, processing, and marketing facilities. This is in line with research by Mulyasari et al. (2018) and Silga et al. (2021), which revealed that most fishermen lack adequate knowledge of climate change and its potential effects on their fish catches and overall fishing operations.

According to adaptation theory (Bennett, 1976), in adapting fishermen's work to climate change, there are at least three main strategies, namely behavioral adaptation, which involves changes in fishermen's behavior in response to changing seasons. Process adaptation involves changes in the way fishermen carry out their work. Fishermen can improve the fishing gear they use or replace it with other types of gear.

Bagan fishing demonstrates resilience through adaptive strategies. Fishermen work in groups to address adverse weather anomalies and to facilitate the transfer of experimental knowledge to locate migratory target species. Some fishermen diversified the technology by converting their boat propulsion system from gasoline to liquefied petroleum gas (LPG). Lastly, the structural reliance on informal patron-client networks has intensified. The patron provides immediate financial assistance and a credit line during the lean season. This technique of chasing the fishing season is one of the innovations implemented to maximize the catch obtained.

Sometimes, fishermen only gather at the port before going to sea. Even though it is just a chat with other fishermen to get information, maybe other fishermen have gone to sea and caught fish. This is in line with the thinking put forward by Scott (1976), which lays the foundation for subsistence ethics. There are three specific strategies: utilizing relationships or social networks and utilizing individuals' kinship relationships, which can help in difficult

conditions. Fishermen can face economic problems during changing seasons by borrowing money and tightening their belts, namely reducing expenses or saving by cutting back on purchases of other goods and focusing only on basic needs.

Conclusions

Fishermen's knowledge and perception of climate change develop from empirical experience passed down over years through interaction with the coastal and marine environment. Vulnerability, as a negative impact, can be minimized through adaptation strategies. Fishermen's social resilience is characterized as a form of reactive adaptation because it is enacted in response to the type of threat or disaster that occurs. In fact, the adaptation being carried out has been planned, given that climate change has been ongoing for a long time.

The results of the study show that the theoretical framework for understanding the impact of climate change is grounded in local characteristics. The informal institutional system also plays a role in the success of adaptation to climate change. The role of informal institutions in playing a social function is to reduce the vulnerability of household livelihoods. This view requires that, in formulating adaptation policies, the community be the basis for program development and decision-making. A critical determinant in constructing social resilience is the optimization of informal institutions. Based on these results, it is recommended to implement an adaptive climate change impact management policy with a participatory approach.

This study has demonstrated the concepts of knowledge, perception, and adaptation efforts to climate change that occur locally in the waters of Lampung Bay. This study also describes the role of institutions, particularly in effectively building social networks. However, several limitations of the study warrant consideration in further research. This study uses a qualitative case study approach with a limited sample size. For this reason, further studies are expected to be quantitative, using an ecological and economic analysis to quantify economic losses due to climate change. In addition, because this study focuses on traditional fishermen, it is necessary to examine the perceptions and adaptation strategies of coastal communities operating in Lampung Bay, particularly in marine cultivation and the fishing industry on a larger scale.

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