Toward a Resilient ASEAN: Reframing Food Security Through Inclusive Climate Adaptation in the Marine Fisheries Sector

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ABSTRACT

Numerous studies indicate that climate change has a tangible impact on marine fisheries catches. Declining fisheries productivity has direct implications for social groups whose livelihoods depend on marine resources, as well as for food security in ASEAN countries that rely heavily on this sector, including the Philippines, Myanmar, Indonesia, and Thailand. This study aims to comprehensively examine the impacts of climate change on the productivity of the marine fisheries sector in the ASEAN region, while also identifying policy gaps and evaluating the effectiveness of community-based empowerment programs based on findings from previous studies. This research is aligned with the frameworks of the ASEAN Economic Community (AEC) and the ASEAN Socio-Cultural Community (ASCC) as part of the regional agenda to protect food security and promote sustainable economic growth. Using a qualitative approach, the study synthesizes theoretical and empirical literature to analyze how the climate crisis affects the income and food security of small-scale fishers across ASEAN countries. The region was selected due to its characteristics as a maritime area with a high level of dependence on the marine fisheries sector. The findings reveal that food security and fisheries policies at the ASEAN level still require improvement, particularly in terms of planning, implementation, and monitoring and evaluation mechanisms. The study also highlights that community-based adaptation and conservation strategies are key to strengthening the resilience of the marine food sector in the ASEAN region. Nevertheless, ASEAN must ensure that its policies and their implementation are inclusive and meaningfully involve small-scale fishers as central actors in the regional marine food system.

Keywords: *Climate Change Adaptation, ASEAN, Food Security, Fisheries Industry, Community-Based Management***.**

INTRODUCTION

Climate change is a phenomenon that affects the natural environment, with a direct indicator being the increase in temperature. To date, numerous studies have demonstrated how the climate crisis has impacted countries around the world, including those in Southeast Asia such as the Philippines, Cambodia, Thailand, and Indonesia (Yusuf, 2009). As an archipelagic nation, Indonesia has already experienced climate

change on a large scale. Climate change in Indonesia can be observed through rising temperatures and shifts in climate variability. For instance, a study released by the World Bank & Asian Development Bank in 2021 indicated that average temperatures in

Indonesia have risen by about 0.3°C per decade since the 1980s. Another study by Aldrian and Djamil revealed that between 1991 and 2005, Indonesia's average annual rainfall reached approximately 2,300 mm. Meanwhile, by analyzing rainfall data from 1981 to 2016, (Avia, 2019) identified significant changes in annual rainfall across several provinces on Java Island, including East Java, Central Java, Jakarta, and West Java.

As the country with the third-longest coastline in the world and the second-largest producer of fish globally, Indonesia's capture fisheries sector is highly vulnerable to the impacts of climate change on marine conditions. Research has shown that a one-degree increase in sea surface temperature can reduce fish catches by nearly 9% (Makwana & Patnaik, 2021). This is because changes in sea temperature can trigger major hydrological shifts that influence the biological, physical, and chemical conditions of the ocean, with significant implications for marine life sustainability. Climate change is even projected to reduce the maximum catch potential of tropical fish stocks by up to 40% by the 2050s (Lam et al., 2020).

The impacts of climate change extend beyond marine biodiversity and fish catches, affecting the economic wellbeing of fishers and coastal communities that rely heavily on natural resources for food and income (Daw, et al., 2009. & Grafton 2010). Small-scale fishers, in particular, are likely to be the most disadvantaged, given their limited access to fishing grounds. Their restricted fishing areas make them more sensitive to climate change. Moreover, the rise of hydro-meteorological disasters such as extreme rainfall, strong winds, and floods has heightened uncertainty in fishing yields, reduced fishing days, disrupted daily activities, and diminished the incomes of small-scale fishers. Mapping the impacts of climate change on small-scale fishers in Southeast Asia has therefore become crucial, as capture fisheries in the region are currently dominated by small-scale fishers.

In Indonesia, the government defines small-scale fishers in the Fisheries Law No. 45/2009 as individuals who fish to meet daily needs, using vessels of ≤5 GT. (Halim 2019) further shows that small-scale fishers in ASEAN countries cannot be captured under a single definition, yet they share common characteristics: they usually operate with small boats (often <10 GT or non-motorized), fish in coastal or inland waters, use simple/traditional fishing technology, produce primarily for household consumption or local markets, and rely heavily on fisheries for livelihoods and food security. Thus, the Indonesian government's definition of small-scale fishers is largely consistent with the broader characteristics found across ASEAN countries.

The influence of climate change on capture fisheries in ASEAN is deeply concerning, as it directly affects regional and national food security systems. According to FAO (2006), food security is a condition in which all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life. The ocean serves as a critical source of protein and livelihood for more than 600 million people in Southeast Asia. A 2022 study by the Food and Agriculture Organization (FAO) revealed that over 70% of populations in ASEAN countries depend on fisheries as their primary source of animal protein, while

revenues from the fisheries sector contribute around 5–8% of GDP in countries such as Indonesia, Vietnam, and Thailand. Fisheries also indirectly support food security by providing income to small-scale fishers, thereby enhancing their purchasing power. However, the adverse impacts of climate change on small-scale fishers' productivity now threaten their food security (Bell, 2017). Consequently, climate change not only poses a threat to the sustainability of marine resources but also heightens the risks of socio-economic inequality, increases the vulnerability of coastal communities, and undermines long-term food security stability.

To reduce the negative impacts of climate change, small-scale fishers must adopt adaptation strategies, which have become a crucial component of the fisheries sector in ASEAN. While previous studies on climate change and fisheries have been conducted at the international scale, most have focused on impacts on ecosystems (Doney et al., 2012; Guldberg & Bruno, 2010), fisheries productivity (Plagányi, É., 2019), and food security (David, 2021). However, there is still limited literature assessing how adaptation strategies directly affect the incomes of small-scale fishers and household food security, particularly in the ASEAN context where fisheries are essential.

As emphasized by Heffron (2020), it is vital to examine country-specific research so that over time, different nations can learn from one another's laws and policy best practices to ensure the development of a fair and operationally sustainable fisheries sector. Against this background, this paper presents an analysis of the small-scale fisheries sector in Indonesia. Indonesia is one of the largest countries in the world by population (274 million people, ranking fourth globally) and a key member of ASEAN, representing about 44% of the region's population. As a maritime nation, Indonesia has a high dependency on fisheries, both in terms of production and consumption.

To address this gap, the study aims to examine the impacts of climate change on marine ecosystems in ASEAN, as well as the socio-economic consequences for small-scale fishers' adaptation models in Indonesia. This article also seeks to contribute to the literature on climate justice, adaptation, and food sustainability fields that remain underexplored despite their urgency by analyzing how climate change affects the productivity of marine fisheries and its implications for fishers' incomes and coastal communities' food security.

METHODS

This study employed a narrative literature review of relevant articles published in academic journals, books, and reports from reputable institutions between 2000 until 2025. The narrative literature review method is used to analyze previous studies in order to gain a deeper understanding of a particular topic, while also identifying research gaps and opportunities for exploring new issues (Nahdiyin, 2023). Only works written in English and Indonesian were included and reviewed. During the study, we searched for and identified articles using specific keywords and search engines to retrieve relevant publications. As a result, a total of 368 documents were initially identified through the database search process. The abstracts of these articles were then reviewed to assess

their relevance to the study's objectives. Through this method, 60 documents were subsequently selected and further analyzed.

Several reasons accounted for the exclusion of documents during the screening and eligibility assessment process. This included duplication, publications outside the specified timeframe, and lack of relevance to the research focus. All the articles screened and analyzed in this study were retrieved from academic databases such as Google Scholar, Elsevier, Springer, Taylor & Francis, and JSTOR. Multiple keywords were used, including climate change, fisheries sector, small-scale fishers, food security, climate change adaptation, and community-based management.

The selected articles were evaluated at two levels: (1) to provide a more comprehensive global overview of climate change, food security, and food sovereignty; and (2) to assess the identified concepts and practices in the Indonesian context with the aim of applying them locally (Gunaratne et al., 2021).

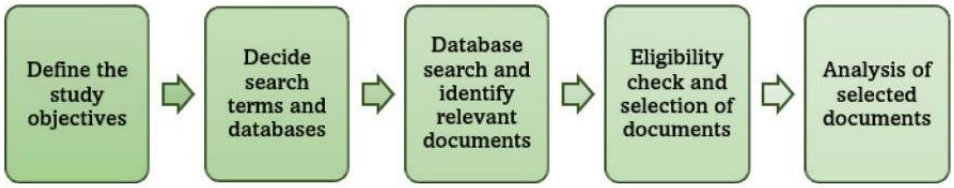

Figure 1. The selection process of the articles for review and analysis (reproduced from Gunaratne et al., 2021).

RESULT AND DISCUSSION

Impacts on Marine Ecosystems

Marine ecosystems provide essential services, including supporting biodiversity and fisheries. However, climate change and human activities are increasingly disrupting these systems, affecting species, habitats, and ocean productivity.

Ocean Acidification

Global warming is caused by the excessive increase of greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), nitrogen oxides (NO_x), chlorofluorocarbons (CFCs), and other gases in the atmosphere (Varabih & Fitri, 2024). Cumulatively, ASEAN has contributed emissions totaling 1.76 Gt CO_2, with the energy sector as the main contributor, while country-level emission data are summarized in recent review studies (Rehman et al., 2024).

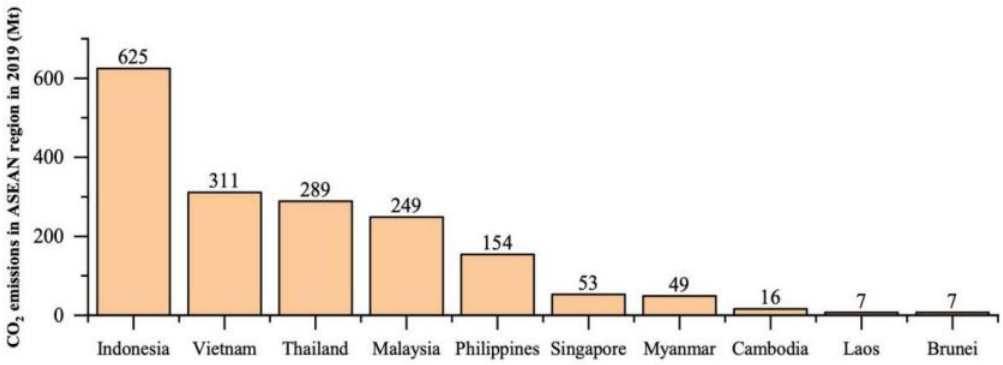

Figure 2. CO_2 emissions by country in the ASEAN region in 2019 (adapted from Rehman et al., 2024, based on IRENA data).

Based on the visual diagram, five countries emerge as the largest emitters in the ASEAN region, namely Indonesia, Thailand, Vietnam, the Philippines, and Malaysia. Emissions are primarily driven by energy sector demands, with contributions of 38% from electricity and heat production, 13% from transportation, 29% from industry, 6% from buildings, and 14% from other sources (Rehman et al., 2024). If these increasing emissions are not mitigated promptly, they will not only exacerbate climate change but also contribute to ocean acidification.

The ocean serves as a natural carbon sink, yet the absorption of approximately 1 million tons of carbon per hour has caused large-scale changes in seawater chemistry, a process known as anthropogenic ocean acidification (Gattuso et al., 2013). It has been recorded that the rising concentration of carbon dioxide has increased ocean acidity by 30%. Globally, the average seawater pH has declined from 8.2 to 8.1 and is predicted to decrease further by approximately 0.4 units (Haiqal et al., 2021). This decline in pH corresponds with reduced formation of calcium carbonate ($CaCO_3$), a critical component of marine biodiversity habitats (Amaya-Vías et al., 2023; Johnson et al., 2022). In addition to fish experiencing diminished ability to detect predators, the population of calcifying plankton has also decreased, disrupting the base of the food chain (Abid et al., 2025).

Ocean acidification leads to lower species classification levels, altered species composition, and disrupted trophic dynamics, thereby compromising ecosystem resilience and function, and potentially impacting coastal communities dependent on fisheries (Sun, 2024).

Ocean Circulation and Upwelling Patterns

Ocean currents are the movement of large masses of seawater influenced by wind, temperature differences, salinity, and the Earth's rotation. These currents play a crucial role in distributing heat, nutrients, and marine organisms throughout the oceans. For marine life, particularly fish, ocean currents are key factors determining migration patterns. However, rising sea surface temperatures trigger the formation of water column stratification, a condition in which layers of water with different temperatures

and densities form, inhibiting vertical mixing and making surface currents more dominant (Daud et al., 2025).

This phenomenon leads to anomalies in upwelling patterns. Upwelling is the process by which nutrient-rich deep water rises to the ocean surface (Juita et al., 2025). Upwelling is especially important because these areas are rich in nutrients, making them highly productive with high concentrations of chlorophyll-a and plankton, and therefore potential hotspots for abundant fisheries (Hidayat & Furqan, 2024). Some studies have shown that during upwelling events, fertility can increase up to tenfold compared to normal conditions (Mann & Lazier, as cited in Syahailatula & Wouthuyzen, 2023). Anomalies in upwelling can disrupt the level of marine primary productivity.

Risk to Habitats

ASEAN is a strategic region for coral reef growth due to its inclusion in the Coral Triangle. The Coral Triangle spans Indonesia, Malaysia, the Philippines, Timor-Leste, Papua New Guinea, and the Solomon Islands. As shown in Figure 3, the ASEAN region is located within the Coral Triangle, which hosts the highest coral diversity in the world, making it a central area for ASEAN's marine ecosystems.

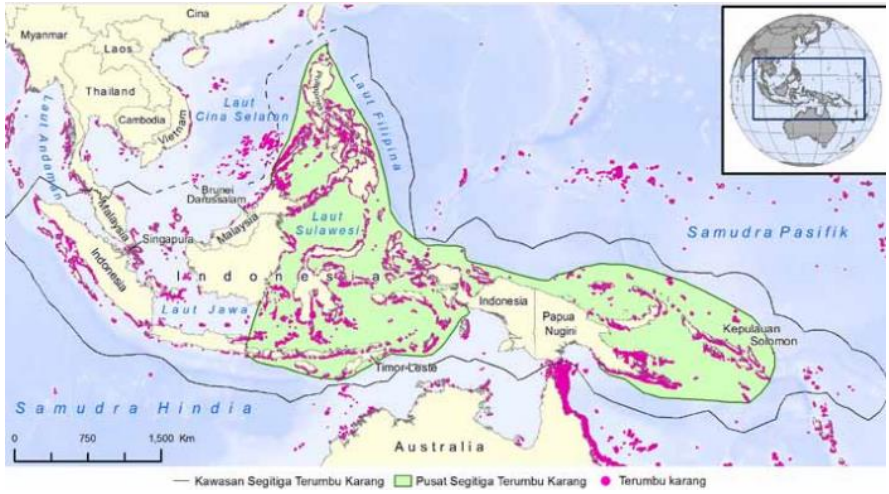

Figure 3. The Coral Triangle region and coral reef distribution in Southeast Asia (adapted from WRI, 2015).

According to a report from WRI Indonesia, climate change is causing massive coral bleaching, which, if left unaddressed, could threaten more than 90% of coral reefs by 2030 and nearly all reefs by 2050 (WRI, 2015). The increasing frequency of bleaching events threatens the ability of branching corals to fully recover after disturbances, reducing the amplitude of boom-and-bust cycles and the key habitat structures they provide for reef fish (Wilson et al., 2019). The vulnerability of the Coral Triangle region also has significant implications for ASEAN countries that export fish, particularly tuna, which generate a total annual revenue of approximately 1 billion USD (Mujiono & Oktaviani, 2021). This also affects other potential fishing grounds, which are compromised due to climate change.

Impacts on Fisheries

Climate change, by making fishery habitats unsafe and unpredictable, creates a situation where climate risks intersect with issues of marine resource availability.

Changes in Fish Distribution

Climate risks make marine ecosystems increasingly uncertain. One of the most concerning impacts is on fish species. Research by Boyce et al. (2022) indicates that high climate risk without mitigation places nearly 90% of fish species in critical condition. Species are expected to experience habitat mismatches across 85% of their current range, with fewer than 1% classified as negligible risk. Climate risks also lead to a drastic increase in threats to apex predators such as sharks and marine mammals. The region's most vulnerable to climate change impacts include tropical, coastal, and polar areas. Annual extreme temperature risks have also been studied in Exclusive Economic Zone (EEZ) areas, showing significant impacts on a 77% decline in marine biomass stocks (Cheung et al., 2021).

Climate change can drive species to move to cooler or more humid regions (Maknun, as cited in Karmana, 2024). Many animals and plants have been observed shifting their distribution ranges toward the poles or to higher elevations. Literature reviews indicate that a large number of species are experiencing shifts in distribution, behavioral patterns, and reproductive timing, which can potentially disrupt ecosystem interactions and damage ecological balance (Karmana, 2024). Several studies have examined the potential shifts in fish distribution, including species such as bigeye tuna, skipjack tuna, herring, plaice, hake, sole, and horse mackerel (Chan et al., 2017; Baudron et al., 2020). Consequently, areas that were previously rich in fishery resources are experiencing declines in stock availability due to these distributional shifts.

Fish Stock Productivity

Data show that more than 230 fish populations capable of reproduction have, on average, declined by approximately 83% compared to the past. Only a few populations can recover quickly, while most show little change even 15 years after experiencing significant declines (Hutchings & Reynolds, 2004). Global marine fish catches have averaged 80 to 91 million tons per year since 1990. However, by 2016, catches had reached a saturation point at around 53.6 million tons per year (Lam et al., 2020). Furthermore, commonly consumed fish species (table fish) have declined drastically by 66% over the last 100 years (Christensen et al., 2011).

It is estimated that by 2050, fish will still exist but primarily small species such as anchovies, sardines, shrimp, and squid. This phenomenon is known as *fishing down the food web*, which refers to the stage when fishers begin targeting species lower on the trophic level due to scarcity (Pauly et al., 1998). In addition, tropical regions are the most affected by climate change because they experience the highest temperatures compared to other regions. This is also related to the characteristics of tropical fish, which are more sensitive to warming due to their narrower thermal tolerance ranges

compared to temperate species, such as tuna and marlin. The decline in fish stock productivity has also led to a reduction in maximum sustainable catches by approximately 6% (Cheung et al., 2021). This situation poses a significant threat to communities that depend on the ocean for their livelihoods, such as those in ASEAN countries.

Consequences of Climate Change for Small-Scale Fishermen in Indonesia

Economic Consequences

Fluctuations in Fish Catches

Fluctuations in fish catches are one of the tangible impacts of climate change felt by small-scale fishermen in Indonesia. Increasingly unpredictable sea conditions, characterised by changes in sea surface temperature, wind direction, rainfall and high waves, have caused fishermen to lose certainty in determining the season and location for fishing. In the Lampung region, for example, capture fisheries production has declined significantly over the past five years. This decline is closely related to climate uncertainty and the increasing frequency of extreme weather events that hamper fishing activities. Empirical data shows that most fishing households in Lampung are still highly dependent on the capture fisheries sector, with an average contribution to household income of 82.22%, and in Tanggamus District the proportion is even higher at 86.22%. This high level of dependence makes fishermen increasingly vulnerable to climate shocks that affect their catches (Riantini et al., 2022).

Similar conditions were also found in North Aceh, especially among tuna fishermen. A study by (Chan et al., 2023) reported that increases in sea surface temperature, accompanied by increases in wave height and wind speed, have driven tuna to migrate to more suitable habitats. As a result, fishermen reported that it was becoming more difficult to catch tuna compared to previous generations. Fishermen in the Spermonde Islands, South Sulawesi, have also experienced a significant decline in catch productivity due to changes in seasonal patterns and an increase in the frequency of extreme weather (Idrus et al., 2024). These situations reflect how climate change not only affects catch numbers but also the geographical distribution of fish stocks.

Decline in Fishermen's Income

The decline in fish income certainly has implications for fishermen's income. Based on the ILO (2018, cited in Relung Indonesia, 2024), the income of traditional Indonesian fishermen has declined by 30% over the past few decades. The average monthly income of small-scale fishermen in a study in East Java by Rahman et al. (2021) was only USD 189.36. This amount is far below Indonesia's national per capita income average in 2019, which reached USD 347.9. In fact, for fishermen who did not implement adaptation strategies, the average income was only USD 158.76 per month, while fishermen who adapted were able to earn USD 225.45 (Rahman et al., 2021). This 42% difference shows that the ability to adapt is an important factor in determining the welfare of fishermen.

In Lampung, a study of 166 fishing households showed that climate uncertainty and declining marine productivity have affected family income stability. Analysis using the Livelihood Vulnerability Index (LVI-IPCC) revealed high income vulnerability, with scores of 0.39 in Bandar Lampung and 0.36 in South Lampung. These conditions indicate high exposure to the risk of income decline, which impacts fishermen's ability to meet basic needs such as food, education, and health. On the other hand, Tanggamus District recorded a negative value (-0.29), indicating a relatively lower level of vulnerability due to better local adaptation (Riantini et al., 2022). Studies in Aceh also prove that income decline is a real phenomenon. The Present Value calculations conducted by (Chan et al., 2023) show significant economic losses for both small boat fishermen (<5 GT) and large boat fishermen (>5 GT). However, the sharpest decline in income was experienced by small boat fishermen, indicating that this group is much more vulnerable to the impacts of climate change. Fishermen with larger boats have the flexibility to fish in more distant waters, follow shifts in fish stocks, and are more resilient to deteriorating sea conditions.

Vulnerability of Fishermen

The vulnerability of fishermen in Indonesia is exacerbated by climate change. Based on data from the Indonesian Ministry of Maritime Affairs and Fisheries, there are approximately 2.7 million fishermen in Indonesia who are fishermen with small boats or can be considered traditional fishermen with simple fishing gear. Most of these fishermen are also affected by high levels of poverty. Data presented by the Central Statistics Agency (2020) shows that the poverty rate among fishing communities is around 25%. This is higher than the national average of 9.87%. The vulnerability of small-scale fishermen is not only reflected in their low income, but also in their socio-economic conditions, which limit their ability to adapt. In East Java, in terms of institutions, only 50% of fishermen are involved in fishermen's groups, and around 55.9% have access to credit (Rahman et al., 2021).

Increased Operational Costs

Climate change also has an impact on increased operational costs for fishermen, especially small-scale fishermen. Weather fluctuations, shifts in fish locations, and the need for technological adaptation make fishing activities increasingly expensive and disproportionate to the catch. A study conducted in Rampa Village, Kotabaru, shows that almost all fishing boats now use engines, and most are even equipped with GPS to determine fishing locations. Although this technological adaptation increases the chances of a successful fishing trip, it also adds to costs, especially for fuel and engine maintenance (Ansara & Hamid, 2023). In Aceh, research found that fishermen have to travel longer distances due to declining fish stocks in coastal waters. This has led to an increase in fuel consumption per trip, with fuel costs contributing between 40% and 73% of total operational costs, averaging 54.9% of total fishing costs (Wahyudi et al., 2023). With average operational costs of around IDR 700,000 (≈ USD 46.7, using an exchange rate of IDR 15,000 = USD 1 in 2023) per trip, fishermen's profits are becoming increasingly slim.

Accident Risk and Safety

Accidents and safety are among the factors contributing to economic consequences. Accidents involving fishermen can result in medical costs for the fishermen themselves. Worse still, if the accident is very serious, a fisherman may lose his livelihood. The characteristics of small boats with limited capacity make small-scale fishermen more vulnerable to waves, weather changes, and accidents at sea. Related studies show alarming conditions for the safety of small-scale fishermen. At Jayanti Fishing Port, West Java, there were 16 accidents involving small fishing boats between 2017 and 2022. These accidents resulted in eight fatalities and two missing people, with human error being the main cause in 80% of cases (Mujahid et al., 2022). The absence of safety equipment, such as life jackets and GPS devices, makes fishermen even more vulnerable. Climate change certainly exacerbates the situation by bringing unpredictable extreme weather. In Bengkulu, 94% of small-scale fishermen stated that the risk of accidents had increased due to extreme weather, while 98% reported that operational costs had risen because they had to anticipate bad weather and damage to their boats (Mulyasari et al., 2025). The findings of these studies can be viewed as economic consequences. Maritime accidents not only result in loss of life, but also in the loss of fishermen's assets in the form of boats and fishing equipment. These losses have a double impact: a decline in fishermen's household income and increased social vulnerability. A family may lose its main breadwinner. In a broader context, high safety risks at sea also worsen the livelihood resilience of small-scale fishermen. Limited capital makes it difficult for them to replace losses caused by accidents.

Social Consequences

Local Communities' Dependence on Local Food

Fish is the main source of food for coastal communities in Indonesia, especially for small-scale fishermen. Fish is not only an economic commodity, but also a staple source of nutrition that supports daily consumption. However, this dependence often causes vulnerability because access to fish is greatly influenced by the season, the market, and socio-economic structures. A study by (Gibson et al., 2021) in Komodo District, East Nusa Tenggara, found that more than half of fishing households experienced moderate to severe food insecurity. Nearly 50% of households consumed vitamin A-rich foods less than three days a week, even though fish was available as a major source of protein. Low maternal education (OR 3.8) and poor economic conditions (OR 0.5) were important determinants of food insecurity. The coping strategies that emerged tended to be unsustainable. High-quality fish was sold to buy rice, while household consumption was limited to small fish with lower nutritional value.

A study by Gibson et al (2020) on mother-child pairs in the same location confirmed these findings. More than 50 per cent of pairs did not meet the minimum food diversity standard. Although fish dominated consumption, nutritional diversity remained low. The introduction of fish to children was often delayed due to concerns about allergies and illness. Therefore, although fish is the dominant local food, sole dependence on this

commodity actually increases the risk of micronutrient deficiencies. The Ministry of Marine Affairs and Fisheries (KKP) recorded Indonesia's fish consumption in 2022 at 55.37 kg per capita per year, with a target increase to 62.5 kg by 2024 (Ministry of Marine Affairs and Fisheries, 2022, as cited in Databoks, 2025).

Migration and Social Change

Climate change has triggered migration dynamics among small-scale fishermen in Indonesia. Migration is not only permanent, but also seasonal and daily mobility, which has complex social consequences for coastal communities. A study conducted by (Mutolib et al., 2022) in Limau Subdistrict, Tanggamus Regency, Lampung, shows that 85% of fishermen expanded their fishing grounds as an adaptation strategy to cope with declining catches, while 20% chose to migrate and settle in their destination locations, and around 16.25% took their families with them to settle. A total of 2.5% migrate daily, bringing their families with them. Meanwhile, research in the Mahakam Delta, East Kalimantan, highlights how sea level rise and coastal abrasion have caused massive damage to shrimp ponds, which have been the main source of livelihood for the community (Hidayati & Setiadi, 2020). Many ponds have been abandoned because they are flooded with seawater, forcing households to leave their villages. The decision to migrate to the Mahakam Delta involves economic considerations, such as loss of income, and non-economic considerations, such as damage to homes and environmental degradation. In this case, migration in the region is more of a strategy to maintain household resilience.

Loss of Local Culture and Identity

Climate change not only threatens ecosystems and the livelihoods of small-scale fishermen but also threatens the culture that shapes the identity of coastal communities in Indonesia. For fishing communities, the sea is not only a source of food, but also a cultural space where traditional values, knowledge and practices are passed down from generation to generation. The loss of marine ecosystems also means the loss of Traditional Ecological Knowledge (TEK). This has long been the foundation of their social identity. A study in the Selayar Islands, South Sulawesi, shows that coral reef degradation and declining fish catches have led to the gradual loss of cultural practices among fishing communities. For example, the mappanre leppa ceremony (boat launching) is now rarely performed. Interviews in the study revealed that more than 60% of young fishermen in Selayar admitted that they no longer perform maritime rituals that were once an important part of their cultural identity (Maharja et al., 2023).

This phenomenon is in line with the findings of Pearson et al. (2023), which emphasise that coastal ecosystem degradation triggers the loss of TEK (Traditional Ecological Knowledge). For example, knowledge about the fish season calendar, wind direction, and sea signs. The loss of this knowledge weakens the role of traditional fishermen as guardians of local culture. In the context of Indonesia, which has more than 17,000 islands inhabited by small fishing communities, the risk of losing identity is even greater because sea level rise and coastal erosion have the potential to force communities to

leave the living spaces that are the centre of their culture. This context is further reinforced by the fact that the loss of coastal areas due to sea level rise will erase not only homes, but also cultural sites, local languages, and cultural practices tied to those spaces. (Krupocin et al., 2020).

Gender Role Changes

The increasingly severe climate change not only affects the economic aspects of small-scale fishermen in Indonesia but also changes their social roles at the family and community levels. The tradition of fishermen as the backbone of the family is now increasingly unstable due to the uncertainty of catches. Data from the Ministry of Maritime Affairs and Fisheries shows that the number of fishermen in West Java has declined dramatically, from 91,805 people in 2019 to 63,989 people in 2021, equivalent to an annual decline of 16.51%. (Defina et al., 2024). This situation has forced fishing families to restructure their division of roles. A survey of 456 fishing families shows that the decline in catches has encouraged wives to play a more active role in supporting the household economy, whether through selling fish, processing catches, or other micro-businesses (Defina et al., 2024). This change has transformed family relationships from a male-dominated "single breadwinner" model to households with multiple incomes, where the contributions of women and children have become more prominent. In East Java, a study of 150 fishing households in Prigi Bay showed that fishermen were only active at sea during 68% of the peak season, 20% of the moderate season, and only 12% of the lean season (Susilo et al., 2021). During the lean season, most households rely on diverse livelihoods, including agriculture, animal husbandry, and informal businesses run by wives. This fact shows a shift in the structure of fishing households from male dominance to a more collective distribution of roles.

A similar transformation was also found in a national survey of 503 small-scale fishermen in Indonesia. This study proves that access to internet-based climate information significantly increases fishermen's opportunities to seek employment outside the fisheries sector (Rahman et al., 2025). Thus, the social identity of fishermen is no longer exclusively tied to fishing activities but has expanded to alternative sectors such as transportation services, maritime tourism, and informal businesses. However, this shift in roles does not always occur harmoniously. Research on the coast of West Java shows that increased economic independence for women is accompanied by the risk of domestic conflict. The pressure caused by the decline in men's economic role correlates with an increase in verbal abuse and the risk of divorce (Defina et al., 2024). In other words, although women are increasingly vital to family resilience, gender relations within the household have also become more disrupted.

Adaptation response

The negative impacts of climate change, including sea level rise, coastal erosion, extreme waves, and tidal floods, have significantly reduced fisheries productivity. According to (Macusi, 2021 & Handayati, et al., 2025), small-scale fisheries are the most affected as they heavily rely on fishing activities. This makes climate change adaptation

models crucial to be implemented. In the context of Indonesia, various strategies have been applied to cope with climate change, including the diversification of fishing gear, adjustment of fishing schedules, utilization of social networks, and shifting fishing grounds.

Studies have shown that fishers with prior experience in facing pressures from climate change tend to be more capable of adopting effective adaptation strategies (Mulyasari, 2018). The most common strategy is adjusting fishing times and seeking information about weather and climate change through weather prediction applications. In addition, small-scale fishers tend to choose adaptation strategies that are practical and do not require high costs or specific technologies. This is because small-scale fishers have limited economic resources (Susilo, 2021 & Rahman, 2023).

Besides adjusting fishing times and seeking weather information, the diversification of fishing gear is also one of the most frequently applied adaptation strategies by small-scale fishers (Mulyasari, 2018). Indeed, small-scale fishers still commonly use nets. However, due to changes in fish productivity and seasonality caused by climate change, they now also employ other fishing gears such as lines or hooks. These are chosen because they are easy to use and do not require specific technical expertise. The diversification of fishing gear is believed to increase the chances of small-scale fishers obtaining larger catches.

In essence, climate change adaptation models adopted by small-scale fishers are often constrained by limited access to financial aid or credit. Studies show that fishers with access to credit are more likely to implement adaptation strategies, as limited financial capital can be a barrier to covering adaptation costs. With financial access, fishers can purchase the inputs required to support adaptation (Fosu, 2013 & Mulwa, 2017).

Beyond financial access and assistance, another crucial factor in small-scale fishers' adaptation models to climate change is their participation in fisher groups. Studies demonstrate that participation increases the likelihood of adopting adaptation strategies. This is because such groups provide comprehensive information about fishing activities, including adaptive practices to climate change. Exposure to climate information helps fishers become more proactive in adjusting to climate crises. Climate information not only convinces fishers of the importance of adaptation strategies to reduce climate impacts (Zougmoré, 2016), but also serves as an early warning system that reduces the vulnerability of capture fisheries. Numerous studies indicate a significant positive relationship between the availability of climate information and the implementation of adaptation strategies (Oduniyi, 2019 & Deressa, 2011).

Discussion

Based on the study conducted by Islam and Kieu (2021), food security has long been a central agenda of ASEAN as a regional cooperation organization. ASEAN's cooperation in the field of food security is not limited to its member states but also involves collaboration with countries outside Southeast Asia. ASEAN countries experienced a surge in international food prices during the 2007–2008 period, which raised serious

concerns regarding potential food security threats and their implications for the stability of ASEAN member states. ASEAN's commitment to food security is reflected in cross-sectoral initiatives such as the ASEAN Climate Change Initiative (ACCI), the ASEAN Plus Three Emergency Rice Reserve (APTERR), and the ASEAN Food Security Information System (AFSIS) (Islam & Kieu, 2021).

Despite these commitments and initiatives, which demonstrate ASEAN's recognition of the importance of addressing climate change and food security in the region, Islam and Kieu (2021) identify several shortcomings in ASEAN's current policy and cooperation models. ASEAN's food security initiatives continue to face limitations at the levels of planning, implementation, cooperation, and legal obligations. At the planning stage, most strategies indeed focus on mitigation and adaptation at the regional level; however, ASEAN remains insufficient in formulating long-term measures at the international level. Moreover, existing policies have not adopted a human right–based approach, as they insufficiently prioritize the welfare of vulnerable groups who are disproportionately affected by climate change and should be the primary subjects of protection within climate and food security policies.

At the implementation stage, Islam and Kieu (2021) argue that ASEAN's food security policies remain largely reactive and are characterized by weak monitoring mechanisms. In addition, many ASEAN policies continue to emphasize decision-making by higher authorities, with minimal participation from grassroots communities. This condition contradicts ASEAN's commitments under the ASEAN Socio-Cultural Community (ASCC) Blueprint, which explicitly aims to enhance public participation in ASEAN policymaking processes.

The weaknesses identified by Islam and Kieu (2021) in ASEAN's food security policy framework are particularly critical given that the fisheries sector in ASEAN countries is predominantly composed of small-scale fishers and small-scale industries. Therefore, strengthening capacity in fisheries management is essential. Food security policies in ASEAN should not be oriented solely toward ensuring food availability at the regional level but should also directly address coastal food producers, particularly small-scale fishers and small-scale fisheries industries.

Existing studies indicate that effective fisheries management capacity in Southeast Asia remains far from ideal (Stacey et al., 2021). This situation is further exacerbated by fisheries policies that continue to adopt top-down approaches. In contrast, studies by (Stacey et al. 2021) and Lam et al. (2020) demonstrate that community-based fisheries management constitutes an effective climate change adaptation strategy, as it is grounded in learning cycles that enable communities to respond to continuously changing environmental and socio-economic conditions. (Stacey et al. 2021) further emphasizes that meaningful participation of communities and resource users in decision-making processes is essential. This implies that fisheries management must integrate local institutions, customary practices, and local knowledge. Such approaches have proven successful in several contexts, including Bitung City in Indonesia and

communities in Timor-Leste, where small-scale fish aggregating devices have been utilized to respond to climate-driven shifts in species distribution (Stacey et al., 2021).

Furthermore, Stacey et al. (2021) identify four main factors contributing to the failure of many coastal community empowerment programs. First, community-based marine management models often continue to employ top-down approaches with limited community participation. Second, intervention initiatives frequently fail to account for socio-economic diversity across regions, power relations among local fishers, and the intrinsic value of traditional livelihoods. As a result, alternative community-based marine management practices are abandoned, and fishers revert to previous traditional practices. Third, policy mismatches and weak coordination among governing institutions, combined with the limited authority of local governments, hinder effective implementation. Fourth, small-scale fishers continue to face restricted access to market networks, further undermining the sustainability of their livelihoods (Stacey et al., 2021).

ASEAN needs to strengthen its food security commitments by moving beyond a narrow focus on food security and availability alone. Regional food security cannot be separated from the sustainability of coastal food producers' livelihoods, particularly small-scale fishing communities that constitute the backbone of the marine food supply chain in Southeast Asia. Therefore, ASEAN food security policies should more explicitly integrate the protection, empowerment, and capacity building of small-scale fishers through inclusive, participatory, and community-based approaches, in order to ensure the sustainability of marine resources while simultaneously strengthening regional food security.

CONCLUSION

Climate change is causing serious problems for marine life, fish catches, and the livelihoods of small-scale fishers in ASEAN, especially in Indonesia. Higher sea temperatures, more acidic oceans, and changes in ocean currents are making it harder for fish to survive. These changes are reducing the number of fish available and causing them to move to different areas. This leads to lower catches and less stable income for fishing communities. These issues also make it harder for people to have enough food, threaten their culture, cause people to move, and change how family roles are divided between men and women. Many fishers are trying to adapt by using different fishing tools, changing when they fish, relying on their community ties, and joining local efforts to manage fisheries. But they still need more help, such as financial support, information about climate change, and access to decision-making processes.

At the regional level, ASEAN has launched several projects like the AIFS Framework, SPA-FS, ACCI, and community-based programs. These show that there is more awareness of the need to connect climate adaptation with food security. However, there are still problems with how these efforts are put into action. These include a top-down approach, weak laws, poor coordination, and unfair access to markets. To keep

fish stocks healthy and ensure food security in the region, this study stresses the importance of approaches that are inclusive and rooted in local needs.

These strategies should include conservation efforts, fair governance, equal access to markets, teamwork across different sectors, and practical research. Doing this not only helps protect marine resources but also improves the income, food security, and cultural strength of fishing communities across ASEAN.

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