



# Effects of Climate Change on Fishermen's Livelihoods

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## ABSTRACT

The approaching global population of 9 billion by 2050 propels a 70% surge in food demand, reshaping diets toward meats, fruits, and aquaculture. Climate change poses a threat to fisheries, endangering 1.5B reliant on fish protein. Fisheries, with significant GDP impact and 50% female participation, face crises like warming seas, GHGs, extreme weather, and eroding habitats. Strategies focus on resilient practices, yet cooperative efforts are crucial for fishing communities' sustainability amid climate challenges. Their resilience is pivotal for global food security and economic stability.

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## KEYWORDS

Aquaculture, Fish protein, Climate challenges, Fishing communities, Food security

## Introduction

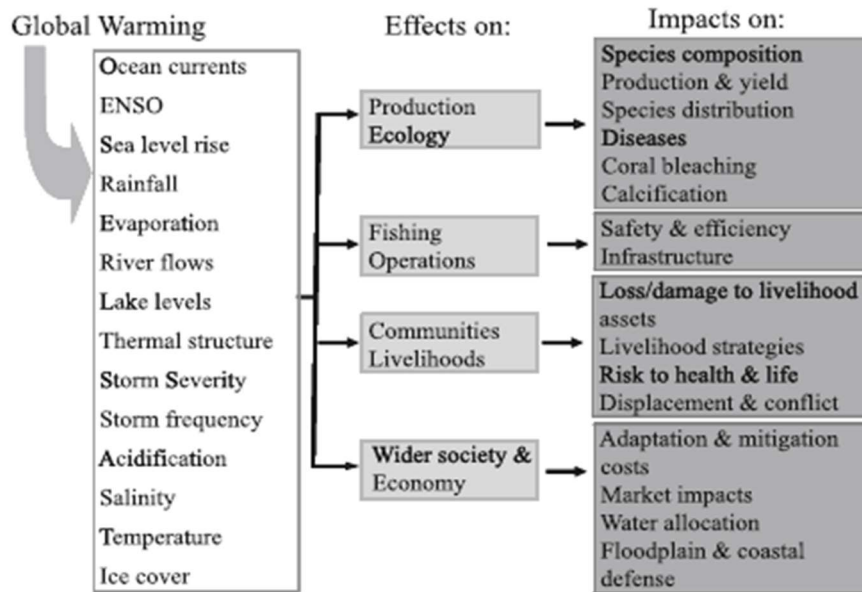
The world's population is projected to surpass 9 billion by 2050, leading to a 70% increase in the global demand for food, feed, and fiber (Rahman, 2016). Furthermore, the ongoing trend of urbanization is expected to trigger significant shifts in lifestyle and consumption patterns. This transformation will likely result in reduced reliance on grains and pulses and a substantial surge in the consumption of vegetables, fruits, meat, dairy, and fish. Aquaculture, with its rich history, plays a vital role in providing high-quality proteins to a growing global population (Nash, 2010; Beyene, 2016; Gui et al., 2018). In recent decades, aquaculture has emerged as the fastest-growing sector within agriculture. Notably, since 2013, the production of aquaculture has outpaced that of wild fisheries (FAO, 2020). This formidable challenge raises concerns regarding implications, particularly in developing nations where poverty and hunger persist (World Bank, 2014). Concerns are developing over how climate change may affect the nourishment and livelihoods of the 36 million fishermen that work around the world as well as the 1.5 billion people who eat fish, which accounts for more than 20% of their animal protein intake. The consequences on fishing livelihoods are expected to be significant as more and more data demonstrates how fluctuations in the climate affect aquatic ecosystems. Regrettably, this domain remains relatively neglected in climate adaptation policies. The fisheries sector holds a prominent position among the most traded categories of food and feed, boasting an export value of \$86 billion in 2006 (Flaherty, 2009). It makes significant contributions to both the overall gross domestic product (GDP) and agricultural GDP while playing a pivotal role in global food security. Moreover, it serves as a vital source of livelihood, with women representing approximately half of the fisheries workforce in countries like India,

Cambodia, and Ghana, engaging in activities both at sea and in post-harvest processes (Salagrama, 2012). Climate change presents formidable challenges to fishing communities worldwide, affecting their livelihoods in multifaceted ways. On a global scale, since the middle of the nineteenth century, the average surface temperature of Earth has increased by more than 0.8°C, and this pace is increasing at a rate that is greater than 0.1°C per decade (Hansen et al., 2006).

The planet's insulating layer is created by greenhouse gases (GHGs) such as carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrogen dioxide (NO<sub>2</sub>), which are mostly to blame for the current warming. The marine environment is predicted to be significantly impacted by long-term climate change, which will affect its ability to support fishing stocks and elevate pressure on marine fish populations. Fisheries with limited mobility, such as small-scale traditional operations, are anticipated to be particularly susceptible to these changes. Important oceanic weather systems are affected by climate change. These systems include sea surface temperature, pH, salinity, sea level, precipitation, El Niño Southern Oscillation (ENSO), cyclone frequency, and drought intensity. The primary drivers of climate change are GHGs, with carbon dioxide, methane, ozone, and nitrous oxide being among the major contributors. The primary outcomes of climate change include rising temperatures and shifts in precipitation patterns. The 20<sup>th</sup> century marked the warmest century in the last millennium, with the 1990s being the warmest decade and 1998 and 2004 as the warmest years (Ge et al., 2013). A similar warming trend is expected in the coming decades, with an estimated increase in temperature. These consequences are far-reaching and include the decline of fish stocks due to changes in marine ecosystems, directly affecting the income and livelihoods of fishing communities. Increased occurrences of extreme

weather events result in damage to fishing infrastructure and disruptions to fishing activities, adding to the economic burden. Coastal erosion and rising sea levels pose threats to coastal habitats and fishing infrastructure, ultimately leading to reduced fish productivity and the potential displacement of communities (Allison et al., 2009). Changes in fishing seasons and migration patterns present challenges for fishing communities, resulting in reduced catches and income instability (Brander, 2010). Diversifying livelihoods becomes increasingly challenging as climate change undermines the sustainability of traditional fishing practices. Mitigation efforts focus on sustainable fisheries management, resilient fishing techniques, and strengthening community adaptation strategies. Effective

collaboration among governments, communities, researchers, and organizations is essential to ensure the long-term sustainability and well-being of fishing communities as they grapple with the complexities of climate change. Addressing these issues is critical not only to safeguard the livelihoods of fishermen but also to maintain global food security and economic stability, which are closely tied to the fisheries industry. Therefore, fostering cooperation among governments, communities, researchers, and organizations is imperative to ensure the resilience and prosperity of fishing communities in the face of climate change.



**Fig 1.** Impact routes associated with global warming and capture fisheries (Source: Badjeck et al., 2010).

### Impact on Fishing Communities

Face increased vulnerability in terms of less stable livelihoods in three major ways:

1. Decrease in availability of quality/quantity of fish for food: 50% or more of animal

protein and nourishment for three billion people.

2. Higher fishing risk:

- Lower Catch per unit effort
- Artisanal fishers moves to explore deep - vulnerable

### 3. Natural Disaster

- 32% lives in kutch house (Jena, 2018)
- Loss of equipment.

#### **The impact of global warming on fisheries is substantial and multifaceted:**

The impact of global warming on fisheries is far-reaching, affecting fish populations, ecosystems, and the livelihoods of those dependent on fishing, including commercial fishing and tourism. Adapting to these changes and implementing sustainable practices is crucial for the long-term health of both marine environments and the communities that rely on them

#### **Climate as a Key Factor:**

Climate plays a pivotal role in influencing the productivity of crucial species in global fisheries. The effects are evident at both the individual organism level and the population level.

#### **Organismal-Level Changes:**

- ✓ Growth: Rising temperatures can lead to changes in the growth rates of fish species, affecting their overall size and development.
- ✓ Reproductive Success: Changes in water temperature and environmental conditions can impact the reproductive success of fish species, potentially leading to reduced populations.
- ✓ Mortality: Warmer waters can increase stress on fish, making them more susceptible to disease and mortality.
- ✓ Habitat: Alterations in temperature and water quality can result in shifts in the habitats that fish depend on for survival.

#### **Population-Level Changes:**

- ✓ Declines in fish stocks have cascading effects on various important aspects:

- ✓ Commercial Fishing: Reduced fish stocks have a direct impact on commercial fishing industries, leading to decreased catches and economic losses.
- ✓ Tourism: Fisheries are closely linked to tourism in many regions. Declines in fish stocks can negatively affect tourism and recreational fishing activities.
- ✓ Biodiversity: Changes in fish populations can disrupt ecosystems and lead to shifts in biodiversity, impacting the delicate balance of marine life.

#### **Habitats and Behavior of Fish:**

- ✓ Habitat Changes: Global warming can cause the expansion or contraction of suitable habitats, such as coral reefs, sea grass beds, and mangroves, affecting the availability of shelter and food for fish.
- ✓ Distribution Shifts: Fish stocks may shift their distribution patterns in response to changing environmental conditions, potentially altering their migration routes and breeding locations.
- ✓ Feeding and Breeding Grounds: Changes in water temperature and habitat availability can reduce or modify the availability of feeding and breeding grounds for fish.
- ✓ Migratory Circuits: Global warming can disrupt the interconnected migratory circuits that fish rely on to complete their life cycles, affecting their overall survival and recruitment.

#### **Possible effects of environmental change on the fishing industry: several avenues**

Alterations in water temperature, precipitation, and oceanographic elements, including factors like wind speed, wave activity, and rising sea levels, have the potential to trigger substantial ecological and biological transformations within both marine and freshwater ecosystems. These changes can directly affect the fish populations inhabiting these environments, consequently impacting the

well-being of communities whose livelihoods are intricately linked to these ecosystems. In addition to these changes in the environment, severe weather can harm onshore infrastructure and interfere with fishing operations. The strategies and results of fishing communities can be further impacted by shifts in the production of fish and other natural resources, which can have an impact on broader livelihoods. Fishermen may be forced to look for alternate sources of income or employment in response to diminishing yields, revenue, and food security. This can put more strain on other industries or resources.

### **Understanding the effects of fluctuations in the climate and transition on communities and households via the lens of livelihoods**

The sustainable livelihoods approach (SLA) provides important insights into how fishery production systems may be impacted by climate change at the household and community levels. These insights may then be used to understand how families and communities can be affected economically and socially (Cochrane et al., 2009). Sea level rise, more frequent storms and floods, and other climate unpredictability and changes can negatively impact a community's physical assets as well as those of individual homes. This not only lessens their capacity for efficient harvesting but also interferes with vital public services and infrastructure, such landing areas, boats, and equipment, that sustain their way of life. Food security and safety at sea are two other areas where climate variability and change have an impact on human capital. The most striking effect of extreme weather events on human capital is the loss of life, which affects not only the surviving members of the family but also has the potential to disrupt social and economic structures and activities outside of the immediate family.

### **Adaptation Strategies**

The adoption of adaptation strategies is of paramount importance for fishing communities as they confront the challenges presented by climate change. These strategies are designed to bolster the ability of these communities to withstand and thrive in the midst of evolving environmental conditions.

**Diversification of Livelihoods:** Fishing communities can explore alternative income-generating activities to reduce dependence on fishing. This can include engaging in aquaculture, coastal tourism, or other related industries. Diversification allows communities to adapt to changing fish stocks and market conditions, providing economic stability.

**Improved Fisheries Management:** Implementing sustainable fisheries management practices is essential for adapting to climate change. This involves setting catch limits, establishing marine protected areas, and promoting responsible fishing practices. Effective management ensures the long-term sustainability of fish stocks and helps mitigate the impacts of climate change on fisheries.

**Enhancing Knowledge and Information:** Access to accurate and timely information on climate change and its impacts is vital for fishing communities. Building capacity through training programs and workshops helps fishermen understand changing environmental conditions, enabling them to make informed decisions about fishing practices, timing, and locations.

**Climate-Resilient Fishing Techniques:** Fishing communities can adopt climate-resilient techniques that are better suited to changing environmental conditions. This may include using more efficient gear, modifying fishing practices, or exploring new fishing grounds. Adapting techniques helps improve catch rates, reduce the ecological impact of fishing, and ensure the sustainability of fishery resources.

**Community-Based Adaptation:** Encouraging community participation and engagement in adaptation strategies is crucial. Community-based approaches involve local stakeholders in decision-making processes and empower them to identify and implement adaptation measures that are most relevant and effective for their specific circumstances.

**Infrastructure and Technology Upgrades:** Investing in resilient infrastructure, such as sturdier boats, storage facilities, and processing centers, can help fishing communities withstand the impacts of extreme weather events. Additionally, adopting technology solutions, such as remote sensing, real-time monitoring systems, and weather forecasting tools, can improve the efficiency and safety of fishing operations.

**Social Safety Nets and Insurance:** Establishing social safety nets and insurance schemes can provide a safety net for fishing communities during times of crisis or when fishing activities are disrupted due to climate change impacts. These mechanisms help protect livelihoods and ensure the well-being of community members.

#### **Enhancing the livelihood platform:**

Improving the livelihoods of fishermen, which involve access to and utilization of five essential capital assets, can substantially reduce their vulnerability. This enhancement can be pursued through a variety of adaptation strategies and policies, either as proactive measures in anticipation of future impacts or as responses to their occurrence. Fisheries-dependent livelihoods will be largely shaped by their capacity to quickly adjust to alterations in environmental conditions by implementing new tools and methods of harvesting. In order to reduce the physical vulnerability to variations in the climate and change, disaster risk reduction measures must be put into place. In coastal regions, the promotion

of mangrove conservation serves as a means to establish natural defenses against rising sea levels and extreme events. Moreover, the amalgamation of urban planning and coastal management can promote the development of residential zones that are impervious to floods or ease the process of evacuation. The preservation of mangroves as carbon sinks through these activities can also help with sectoral mitigation efforts. Moreover, higher levels of education among fishermen can empower them to make a wider range of choices, encompassing safe construction practices and the assessment of potential risks, ultimately leading to fewer casualties in the event of extreme occurrences.

#### **Flexible and varied methods of subsistence:**

It has been posited that fisheries livelihood systems characterized by greater diversity are better equipped to adapt to change, particularly in the face of climatic disruptions. Diversification in this context encompasses several dimensions, such as occupational multiplicity (engaging in multiple income-generating activities), occupational mobility (transitioning between different occupations), spatial mobility (migration), variation within the aqua sector (using several fishing gears and involving different species), and diversification outside the sector (joining or leaving the fishery sector).

#### **Policies and establishments: pliable and versatile**

Geographical and political borders, as well as the compatibility of institutions with ecosystems, present challenges to the management of transboundary fish resources. Given the increased climatic unpredictability and change, these restrictions should only get stronger. For example, expected temperature changes in the Pacific Islands may cause tuna populations to relocate to higher latitudes in the Pacific Ocean. Considering that domestic fleets are restricted to

exclusive economic zones, far water fishing fleets are probably more resilient to these shifts in tuna distribution. This discrepancy could lead to disputes between the two kinds of fleets.

### Responses to climate change:

- ✓ Putting into practice management strategies and policies that strengthen the financial security, lowering susceptibility to different stresses, such as climate change.
- ✓ Developing a thorough grasp of current response mechanisms to shocks and climate variability in order to inform and direct planned adaptation measures.
- ✓ Recognizing the potential opportunities that climate change may offer to the sector, such as new avenues for sustainable practices and resource utilization.
- ✓ Developing adaptable solutions from a multi-sector standpoint, considering the interdependence of many sectors and the possible effects of changing the climate on them all.
- ✓ Acknowledging the fisheries sector's potential contribution to mitigation efforts, including efforts to reduce greenhouse gas emissions and enhance environmental sustainability.

### Conclusion

The repercussions of global warming on the world's fishing communities and the billions of consumers who depend on fish as a crucial source of animal protein in their diets are becoming increasingly worrisome. The effects of climate variability and change on aquatic ecosystems have profound and wide-ranging consequences for the livelihoods of fishermen, yet this critical aspect has largely been overlooked in climate adaptation policies. The global fishing industry, characterized by its significant export value and its vital contributions to both GDP and food security, is facing a clear and present danger due to climate change.

Moreover, fishing communities, particularly women, who are significant contributors to this sector, face a myriad of challenges. Climate change is causing the decline of fish stocks, extreme weather events are damaging infrastructure, and coastal erosion and sea-level rise are threatening habitats and productivity. Changes in fishing seasons and migration patterns further disrupt traditional practices, leading to reduced catches and income instability. Efforts to mitigate these challenges must prioritize sustainable fisheries management, resilient fishing techniques, and community adaptation strategies. Collaboration among governments, communities, researchers, and organizations is crucial to ensure the long-term sustainability and well-being of fishing communities as they navigate the complex and evolving landscape of climate change. It is imperative to address these issues to safeguard not only the livelihoods of fisher folk but also the global food security and economic stability that rely on the fisheries industry. Furthermore, anthropogenic activities are destroying our atmosphere- all the resources that are available in our environment are not only for the present use and also for future-we have to conserve & take effective measures to control these activities also create awareness to public about adverse effect of these phenomena's. Future alterations in the climate have the potential to modify the geographical spread of primary and secondary pelagic production, hence exacerbating the stress experienced by already reduced populations of fish and mammals.

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