Edu Geography
Indexed SINTA, Garuda
Web: journal.unnes.ac.id/journals/edugeo

Volume 13 Edisi 1 Tahun 2025 Hal 109-117
p-ISSN 2252-6684 | e-ISSN 2549-0346
DOI: 10.15294/edugeo.v11i2.69710

The Impact of Climate Change on the Lives of Fishermen at Goa Cemara Beach, Bantul, Yogyakarta

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Article info: (Received: 28 March-2025; Revised: 10 May 2025; Accepted: 29 Juny-2025)

Abstrak: Perubahan iklim telah memberikan dampak signifikan terhadap kehidupan nelayan di Pantai Goa Cemara, Bantul, Yogyakarta. Dampak tersebut meliputi penurunan stok ikan, cuaca ekstrem yang mengganggu aktivitas melaut, abrasi pantai, dan kerusakan ekosistem laut, seperti terumbu karang dan mangrove. Penelitian ini bertujuan untuk menganalisis dampak perubahan iklim terhadap kondisi sosial-ekonomi nelayan serta strategi adaptasi yang dapat dilakukan untuk meningkatkan ketahanan mereka. Metode penelitian yang digunakan adalah kualitatif dengan pendekatan deskriptif. Data dikumpulkan melalui wawancara mendalam, observasi, dan studi dokumen yang melibatkan nelayan lokal, pemerintah daerah, serta pakar lingkungan. Analisis data dilakukan dengan teknik reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa perubahan iklim tidak hanya mempengaruhi hasil tangkapan ikan, tetapi juga menurunkan pendapatan nelayan dan meningkatkan kerentanan sosial-ekonomi mereka. Strategi adaptasi yang telah diterapkan, seperti diversifikasi mata pencaharian, pelatihan teknis, dan kolaborasi komunitas, masih menghadapi berbagai kendala, seperti minimnya akses pada teknologi dan kebijakan pendukung. Oleh karena itu, diperlukan pendekatan holistik yang melibatkan partisipasi aktif nelayan, pemerintah, dan organisasi non-pemerintah untuk menghadapi tantangan perubahan iklim secara berkelanjutan.

Kata Kunci: perubahan iklim, kehidupan nelayan, Pantai Goa Cemara, adaptasi

Abstract: Climate change has had a significant impact on the lives of fishermen on Goa Cemara Beach, Bantul, Yogyakarta. These impacts include decreasing fish stocks, extreme weather that disrupts fishing activities, coastal abrasion, and damage to marine ecosystems, such as coral reefs and mangroves. This study aims to analyze the impact of climate change on the socio-economic conditions of fishermen and adaptation strategies that can be carried out to increase their resilience. The research method used is qualitative with a descriptive approach. Data were collected through in-depth interviews, observations, and document studies involving local fishermen, local governments, and environmental experts. Data analysis was carried out using data reduction, data presentation, and conclusion drawing techniques. The results of the study show that climate change not only affects fish catches, but also reduces fishermen's income and increases their socio-economic vulnerability. Adaptation strategies that have been implemented, such as livelihood diversification, technical training, and community collaboration, still face various obstacles, such as minimal access to technology and supporting policies. Therefore, a holistic approach is needed that involves the active participation of fishermen, government, and non-governmental organizations to face the challenges of climate change in a sustainable manner.

Keywords: *climate change, fishermen's life, Goa Cemara Beach, adaptation*

Introduction

Climate change is a global phenomenon that is increasingly being felt in various parts of the world, including in Indonesia. Climate change is a result of global warming which has a negative impact on people's life activities [1]. The negative impacts of climate change include rising sea surface temperatures, extreme weather intensity, changes in rainfall patterns and large waves [2]. Climate change is one of the biggest challenges of this century that not only impacts the global environment, but also affects various sectors of life, including the fisheries sector which is the main source of livelihood for many coastal communities. Fishermen as a community group that depends directly on natural conditions are very vulnerable to weather changes, rising sea levels, and changes in seasonal patterns that affect their catch. In addition, rising sea levels threaten coastal areas that are home to many fishing communities. Coastal abrasion and seawater intrusion can damage port infrastructure, ponds, and mangrove ecosystems that are habitats for fish and places to lay eggs. For fishing communities, climate change has a direct impact on their sources of livelihood. Changes in sea temperature can disrupt marine ecosystems, including fish migration patterns and water productivity [3]. Some fish species that are the main catch of fishermen have moved to colder waters, reducing catches in previously abundant areas. This condition forces fishermen to go out to sea further, increasing operational costs such as fuel and logistics. Extreme weather disasters, such as storms and high waves, also increase the safety risks for fishermen when going out to sea, and can damage fishing boats and equipment [4]. The impact of climate change on fishermen is not only economic, but also social [5]. Income instability due to declining catches often worsens the living conditions of fishing communities, which are generally at the lower middle economic level. Research by Suwarsih et al. (2019) in Tuban Regency shows that local climate change, such as increased rainfall, average temperature, and flood intensity, has caused a decrease in shrimp production by 25–50% [6]. Research by Sirajuddin et al. (2023) in Bulu Cindea Village, Pangkep Regency, found that local climate change, such as increased rainfall and average temperature, caused a 25–50% decrease in milkfish production between 2013–2021 [7] .

Goa Cemara Beach, located in Bantul Regency, Yogyakarta, is one of the coastal areas that is the center of traditional fishing activities. The fishing community in this area relies on marine products as their main source of livelihood. However, in recent decades, climate change has had a significant impact on the coastal ecosystem and the lives of fishermen at Goa Cemara Beach. In addition to being a tourist area, this beach also witnesses the dynamics of fishermen's lives who must adapt to the challenges caused by climate change. Changes in wind patterns, extreme weather, and decreased marine biodiversity are increasingly pressing issues for local fishermen. Climate change, which is characterized by increasing global temperatures, rising sea levels, and unpredictable weather patterns, has disrupted fishing activities in this area. Warmer sea water temperatures have caused changes in fish distribution, so that many species have migrated to deeper or colder waters. This reduces the availability of fish in the waters around Goa Cemara Beach, which has been the main fishing area for local fishermen. Extreme weather, such as strong winds and high waves, is increasingly occurring in the Goa Cemara Beach area, reducing the number of days at sea for fishermen. The risk of maritime accidents increases, while operational costs such as fuel become higher because fishermen have to go out to sea further to get adequate catches. This situation worsens the economic conditions of fishing communities, most of whom are in the lower middle economic category.

The impact of climate change not only affects the economic sector, but also the social sector. Income uncertainty causes many fishing families to experience financial stress, which can trigger migration, changes in work patterns, or even internal conflict within the community. Moreover, women and children in this community are often the most vulnerable groups to the socio-economic impacts. The economic impacts felt by fishermen on the coast of Goa Cemara are changes in sea temperature and ecosystem damage causing a decrease in fish catches. Fishermen have to go further out to sea due to extreme weather and changes in fishing locations, which increases fuel costs and operational costs. With unstable incomes, many fishermen are forced to rely on middlemen to get loans, which worsens their bargaining

position. Meanwhile, the social impacts felt by fishermen on Goa Cemara Beach due to climate change Uncertainty of income causes fishermen's families to face financial pressure, which can have an impact on meeting basic needs, such as education and health. Some community members choose to look for more stable jobs or migrate to the city. Traditional social structures are disrupted by these changes, which disrupt community harmony. Women in fishermen's families on Goa Cemara Beach often have to bear additional burdens, such as looking for additional income or managing household needs with limited resources and children are at risk of dropping out of school due to limited costs or having to help their families with work. The environmental impacts of Goa Cemara Beach due to climate change worsen the availability of fish resources because coral reefs, mangroves, and other ecosystems are damaged. Coastal erosion is caused by rising sea levels, which threatens fishermen's settlements and other supporting infrastructure. These impacts show that climate change not only threatens the sustainability of fishermen's livelihoods on Goa Cemara Beach, but also disrupts social and environmental stability. Therefore, integrated interventions are needed to address these problems.

Method

In this study, the researcher used a qualitative method with a descriptive approach. The researcher intended to understand a social situation in depth with descriptive data in the form of words. The social situation in question is the Impact of Climate Change on the Lives of Fishermen on Goa Cemara Beach, Bantul, Yogyakarta. This is in line with the statement of Bogdan and Taylor in [8] which explains that qualitative research is a research procedure that produces descriptive data in the form of written or spoken words from respondents and observable behavior. Meanwhile, according to Sugiyono, the descriptive approach (2014) in [9] is a study conducted to determine the value of independent variables, either one or more variables (independent) without making comparisons, or connecting them with other variables. variables. This study was conducted to provide an overview of a variable being studied. The data presented in this study are primary data sourced from in-depth interviews and observations between researchers and informants, namely fishermen at Goa Cemara Beach, Bantul, Yogyakarta, which were conducted directly to the research subjects. The subjects in this study were Goa Cemara Beach Fishermen. Secondary data in this study were taken through previous data related to the main focus of this study, which included documentation and literature studies.

This study uses a purposive sampling technique for selecting informants. According to Miles, Huberman and Saldana (2014) in [10], Purposive sampling is a sample selection process that is carried out intentionally to select participants or cases that can provide the richest and most useful information in answering research questions. The reason for using the Purposive Sampling technique is because not all samples have the criteria that match the phenomenon being studied. Therefore, the author chose the Purposive Sampling technique which establishes certain considerations or criteria that must be met by the samples used in this study. The data collected in this study were through interviews, observations, documentation and literature studies. Interviews were conducted by taking several informants who had been determined by asking several questions that had been provided. Observations were conducted by observing the conditions and situations directly in the research area. Documentation was conducted through photographs for physical evidence, voice recordings to record information from interview results, and literature studies used by taking data sources related to the research theme conducted by the researcher.

The data analysis technique used in this study is the Miles, Huberman and Saldana (2014) data analysis model which includes data reduction, data presentation, and conclusions or verification. Qualitative research does not have an absolute formula for processing and interpreting data, but rather a guideline for organizing data, coding and analyzing data, enriching theories and interpreting data. In the activity of analyzing qualitative data, it must be done continuously until it is felt that there is sufficient data [11].

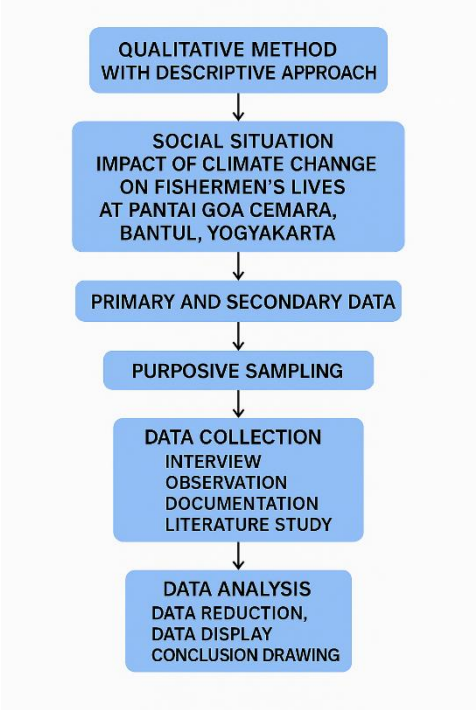

Figure 1. Research Flow Diagram

Results and Discussion

Changes in Weather Patterns and Their Impact on Fishermen's Catches at Goa Cemara Beach

Climate change causes unpredictable weather patterns, such as increased rainfall intensity, changes in wind seasons, and rising sea temperatures. According to the Intergovernmental Panel on Climate Change (IPCC), climate change includes changes in temperature patterns, rainfall, wind, and extreme weather events due to human activities and natural processes [12]. Other experts, such as Houghton (2004), state that climate change is largely caused by increased concentrations of greenhouse gases due to the burning of fossil fuels and deforestation [13]. Climate change refers to the shift in average weather conditions that occur over a long period of time in a region or globally. At Goa Cemara Beach, this phenomenon has a significant impact on fishermen's activities. Seasons that were previously predictable are now difficult to predict, so fishermen often experience a decrease in catch due to fish migration to colder or deeper waters. Higher sea surface temperatures affect fish distribution and populations, as some fish species prefer certain temperatures. Stronger winds and erratic waves make it difficult for fishermen to go to sea safely. Changes in the rainy and dry seasons have become more unpredictable, affecting the best time to go to sea. Events such as storms or high waves occur more frequently, endangering the safety of fishermen and their equipment.

Damage to Coastal Ecosystems and Fish Habitats at Goa Cemara Beach

Coastal ecosystems are unique ecosystems because they are transitional areas between terrestrial and oceanic ecosystems. The influence of both ecosystems forms new and different characteristics of the two ecosystems that influence each other. Ecosystems in coastal areas are natural ecosystems that are very productive, unique and have high economic value and support the Indonesian economy [14]. Coastal ecosystems include typical ecosystems in the border areas between the sea and land that have high productivity, such as many species of fish, mangrove ecosystems, seagrass beds and coral reefs, which

mutually support the environmental ecosystem and the socio-economic life of the surrounding community [15].

Goa Cemara Beach is located in Patihan Hamlet, Gadingsari Village, Sanden District, Bantul Regency, Special Region of Yogyakarta, Indonesia. This beach is about 30 km from the center of Yogyakarta City and is located on the south coast of Java Island. Geographical Coordinates -8.0390° S and longitude 110.2890° E. Goa Cemara Beach is located on the south coast, directly adjacent to the Indian Ocean. The expanse of black sand typical of the south coast and densely growing shrimp pine trees create a shady and cool atmosphere around the beach. Goa Cemara Beach is close to Kwaru Beach and Pandansimo Beach.

The damage to the coastal ecosystem and fish habitat at Goa Cemara Beach due to climate change is a very significant problem because it causes (1) rising sea levels which causes coastal erosion to become more intensive, so that the coastline shifts. This causes damage to coastal habitats, including the shrimp pine trees which are characteristic of the beach. (2) the lives of fishermen who depend on marine resources can be affected by changes in sea water temperature and damage to habitats such as coral reefs, and the impact is that fish populations decline. (3) the increase in the number and intensity of storms along with rising sea levels causes coastal erosion, which endangers the ecosystem around Goa Cemara Beach. (4) many species are threatened with extinction due to climate change which disrupts the balance of the ecosystem. They can also migrate to better places to survive. (5) The fisheries and tourism businesses, which are an important part of the local economy of Goa Cemara Beach, have also experienced damage to the coastal ecosystem, which has caused a decrease in income and increased social vulnerability in the Goa Cemara Beach area.

To maintain the sustainability of the Goa Cemara Beach ecosystem and help the surrounding community, mitigation and adaptation actions must be taken immediately. Mitigation actions can be carried out by (1) ecosystem restoration by restoring marine habitats around the coast such as coral reefs through coral transplantation and reducing the risk of erosion and seawater intrusion by replanting coastal vegetation such as pine and mangroves. (2) reducing carbon emissions, encouraging the use of renewable energy such as wind or solar around the coast and reducing activities that produce high carbon emissions such as excessive use of fossil fuels. (3) waste management, promoting waste management programs, especially plastic waste, which often pollutes the marine ecosystem. And creating a waste-free zone around the coast [16]. In addition to mitigation measures, adaptation adjustments must also be made to maintain the sustainability of coastal ecosystems by (1) strengthening infrastructure, by building wave breakers, both natural and artificial, to protect the coastline from erosion and providing irrigation systems and clean water management that are resistant to incoming seawater. (2) community education and empowerment, educating the community about the importance of maintaining coastal ecosystems and the impacts of climate change and educating fishermen about sustainable fishing techniques. (3) diversifying income sources, developing an environmentally friendly ecotourism-based tourism sector, which helps communities start small businesses such as local arts. (4) forming ecosystem monitoring groups to find out early about environmental changes. Increasing research on ecosystem conditions and species to support data-based policies. (5) creating conservation zones in vulnerable areas to protect the unique flora and fauna of Goa Cemara Beach. Strictly regulating development activities around the coast [17].

The Goa Cemara Coast ecosystem can be maintained while improving the welfare of local communities with a combination of mitigation and adaptation. Mitigation such as mangrove restoration, waste management, and carbon emission reduction help restore damaged ecosystems and prevent further damage. Adaptation such as marine habitat rehabilitation, conservation zone management, and replanting of coastal vegetation helps the ecosystem to survive. Training and education on climate change, marine resource management, and environmentally friendly technologies make local communities better prepared to deal with change. By combining mitigation and adaptation, resource exploitation can be balanced with conservation. This ensures that fish stocks and biodiversity are maintained for future generations. Adaptive infrastructure such as natural breakwaters and mangrove planting reduce economic and social losses by protecting communities from extreme weather and disasters. Mitigation

and adaptation often require collaboration between governments, local communities, non-governmental organizations, and academics.

One of the community groups that is highly dependent on marine resources for its life is fishermen. However, various factors, both internal and external, often cause their socio-economic conditions to be in the vulnerable category. This includes the internal conditions of many fishermen who have limited access to formal education [18]. This leads to a lack of knowledge on how to sustainably manage marine resources and how to adapt them to current technology. Many fishing communities live in remote areas and do not have good access to health services, schools and other public facilities. Traditions and customs often influence the lives of fishermen, and these customs sometimes cannot be adapted to technological advances or environmental conditions [19]. Although fishing communities usually have strong social ties, in some cases, this can be a barrier to the adoption of innovations or the management of resource conflicts.

The lives of fishermen on Goa Cemara Beach are affected by various problems, such as climate change and ecosystem damage. Fishermen have to change their schedules and fishing methods due to weather changes, which impacts the rhythm of their family life. The social structure of coastal communities is often changed by migration to the city to find work after the catch decreases. Conflicts between fishermen or community groups can arise as a result of limited resources. Access to fishing zones or the provision of assistance are often the reasons for disputes [20]. If they do not have much catch, many fishermen must rely on government or social assistance, which can interfere with their independence. Fishermen's traditions and culture, such as sea rituals or traditional fishing technologies, can be lost due to changes in lifestyle.

The impact of climate change on the economic life of fishermen at Goa Cemara Beach. Fishermen's income is directly affected by the decline in fish catches due to habitat destruction and climate change. Operating costs such as fuel and fishing gear increase, while income remains the same or decreases. Fishermen are very vulnerable to environmental disturbances and fluctuations in fish prices because they depend on the fisheries sector. In [21] explained that fishing families face a greater financial burden because they are not prepared for natural disasters. In addition, the competitiveness of fishing products is reduced in domestic and international markets if the quality of the catch or production volume decreases. Many fishermen do not have the capital, access, or knowledge needed to switch to other sectors, even though there is potential for diversification such as ecotourism or fish farming. The financial condition of fishing families who want to start a new business is getting worse because of the difficulty in getting credit or business capital assistance.

There are solutions to reduce these impacts in [22] It is explained that it is necessary to (1) provide skills training and access to business capital to fishermen to diversify income; (2) provide insurance and social security to fishermen to reduce the burden of economic risk; (3) provide training to fishermen on sustainable fishing techniques and new technologies to increase catches; and (4) integrate government programs, non-governmental organizations, and local communities to achieve long-term solutions. This socio-economic impact mitigation will help fishermen on Goa Cemara Beach face environmental challenges and climate change because with the socio-economic impact mitigation, fishermen do not fully depend on fish catches due to climate change because there are alternative jobs such as ecotourism, fish farming, or micro businesses. Fishermen have the ability to adapt to changing conditions through training on sustainable fishing techniques, marine resource management, and the use of new technologies [23].
To maintain the economic stability of families, fishermen's insurance and social protection programs help reduce losses due to disasters or catches. Fishermen can sell their catches at more competitive prices thanks to government support and marketing programs that improve access to domestic and international markets. Reconstruction of coral reefs, mangroves, and other marine habitats increases the availability of fish so that marine resources can be used sustainably. Community solidarity that is able to face environmental challenges is formed through cooperation between fishermen, the government, and other institutions. Fishermen have a comprehensive strategy to survive in the midst of climate and ecosystem changes by combining mitigation (emission reduction, waste management) and adaptation (infrastructure development, training) Fishermen can reduce risks and increase catches thanks to weather

monitoring technology and more efficient fishing gear. Fishermen's lives become more stable and are able to provide benefits to future generations by reducing dependence on unsustainable practices and opening up new opportunities. These mitigation measures ensure that fishermen at Goa Cemara Beach continue to have a sustainable livelihood and have the ability to adapt to adversity [24].

Goa Cemara Coast Fishermen's Adaptation Strategy in Facing Climate Change

Climate change has become a serious challenge for the fisheries sector, especially for fishing communities that are highly dependent on marine ecosystems for their livelihoods. Impacts such as rising sea temperatures, changing weather patterns, declining fish stocks, and coastal abrasion threaten the survival of fishermen, both economically and socially. Therefore, a comprehensive adaptation strategy is needed to help fishermen face these challenges and maintain the sustainability of marine ecosystems. Goa Cemara Beach fishermen can use the Adaptation Strategy proposed by [25] for Fishermen in facing climate change by following the steps (1) diversifying livelihoods by developing nature-based tourism sectors, such as providing tour boat services, tour guides, or managing homestays. Switching to seaweed or fish farming, which are more resistant to weather changes. In addition, it can also develop businesses that process marine products, such as making processed fish products such as crackers, shredded fish, or salted fish, to increase fishermen's income. (2) utilizing modern technology switching to selective fishing gear that does not damage marine habitats, such as nets with certain holes that prevent the capture of small fish, and using applications or devices that provide information about weather and sea waves in real time. (3) increasing the capacity and education of fishermen by educating fishermen about fishing methods that do not damage the environment and providing them with an understanding of the impacts of climate change and the importance of adaptation. (4) improving infrastructure and supporting facilities by creating infrastructure to prevent damage to the coastline due to rising sea levels. facilitating fishing activities and providing port facilities that are resistant to extreme weather. (5) ecosystem rehabilitation and management by involving fishermen to repair mangrove forests and coastal vegetation that prevent abrasion. Supporting coral reef transplantation programs to restore fish habitats and creating conservation zones to maintain sustainable fish stocks in fishing areas. (6) risk management and social protection, by providing insurance services that protect fishermen from losses caused by natural disasters or bad weather. establishing emergency funds to help fishermen when weather or disasters occur. (7) collaboration and partnerships by accessing assistance programs, training, or business capital, fishermen must work together with government or non-governmental organizations. involving fishermen in scientific research on how climate change affects marine ecosystems. (8) sustainable management of marine resources, to maintain the sustainability of marine resources, divide fishing areas and set catch limits in accordance with fish stock management policies. Goa Cemara Beach fishermen can maintain the sustainability of the marine ecosystem, which is their main source of income, while also adapting better to climate change by implementing these strategies.

Conclusion

The lives of fishermen at Goa Cemara Beach, Bantul, Yogyakarta, are greatly affected by climate change. Rising sea temperatures, changing weather patterns, coastal abrasion, and declining fish stocks are the main challenges that threaten their social and economic survival. This condition is worse because there is no advanced technology, supporting infrastructure, and adequate social protection. However, fishermen at Goa Cemara Beach have great potential to overcome this problem by using a comprehensive adaptation approach. Goa Cemara Beach can be an example of success in facing the challenges of climate change with the support of inclusive policies, access to training and social protection, active participation of the fishing community, and the use of environmentally friendly technology, sustainable ecosystem management, and livelihood diversification. A comprehensive adaptation method will protect the marine ecosystem and ensure the sustainability of the lives of fishermen in the area.

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