Journal of Sumatera Sociological Indicators
Journal homepage: https://talenta.usu.ac.id/jssi

Analysis of Adaptive Behavior of Coastal Communities in Facing Climate Change Through Case Studies in the North Coast of Java

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ARTICLE INFO

Article history:
Received: 26 April 2025
Revised: 13 May 2025
Accepted: 21 May 2025
Available online: 27 May 2025

E-ISSN: 2830-5388
P-ISSN: 2541-6642

How to cite:
Desmon, S. A. (2025). Analysis of Adaptive Behavior of Coastal Communities in Facing Climate Change Through Case Studies in the North Coast of Java. Journal of Sumatera Sociological Indicators, 4(1), 368-375.

https://doi.org/10.32734/jssi.v4i1.20637

ABSTRACT

Climate Change is one of the most vital issues that hamper the lives of people in coastal areas. This is characterised by rising global temperatures, more frequent extreme weather, and rising sea levels. The above impacts are very worrying, especially in coastal areas as analyzed by Press (2023) where sea level rise affects coastal structures and habitats and the north coast of Java causing sea level rise, ecosystem damage, and socio-economic impacts for coastal communities. Indonesia has thousands of kilometer of the coastline and mainly affected with climate change impacts especially the Java northern region. Communities in the coastal areas are feeling the impacts most where impacts range from erosion of sandy beaches, intrusion of salt water into freshwater sources, tidal inundation and shifts in ecosystems with consequences on livelihoods. This research deals with understanding how these coastal communities have adjusted or responded to such changes. Employing systematic integrated review methodology, this research aims at articulating and making sense of available academic data that outlines how these communities are coping through shifts in agricultural practices, enhanced housing structures, and development of other economic opportunities. Using behaviorism theory by B.F.Skinner, the paper depicts a scientific understanding of how adaptive behaviors are maintained. The results will be useful in advising local policymakers as to the most effective strategies for improving the resilience of communities to climate change.
Keyword: Adaptive, Coastal, Qualitative, Behavioral Theory

ABSTRAK

Penelitian ini membahas perilaku adaptif masyarakat pesisir Pesisir Utara Jawa dalam menghadapi dampak perubahan iklim, seperti abrasi pantai, intrusi air laut, dan banjir rob. Peningkatan suhu dan kenaikan permukaan laut mengancam kehidupan dan mata pencaharian masyarakat pesisir di wilayah ini, yang padat penduduk serta menjadi pusat aktivitas ekonomi. Studi ini menggunakan metode kualitatif dengan pendekatan studi literatur sistematis, menganalisis perilaku adaptif masyarakat berdasarkan teori perilaku B.F. Skinner, terutama dalam konsep pengkondisian operan. Data diperoleh dari jurnal ilmiah, laporan penelitian, dan buku, yang diakses melalui basis data akademik. Analisis dilakukan melalui identifikasi tema-tema adaptasi seperti modifikasi struktur bangunan, diversifikasi mata pencaharian, serta konservasi lingkungan. Hasil penelitian menunjukkan bahwa strategi adaptasi yang berhasil, seperti perubahan praktik pertanian dan perikanan, diperkuat oleh konsekuensi positif, sementara strategi yang kurang efektif cenderung dihindari. Meskipun demikian, terdapat hambatan berupa keterbatasan sumber daya dan rendahnya kesadaran masyarakat terhadap konservasi. Penelitian ini memberikan wawasan penting bagi perancangan kebijakan adaptasi yang lebih efektif, serta membantu pemahaman lebih lanjut tentang dinamika perilaku adaptif dalam menghadapi perubahan iklim di kawasan pesisir.
Kata Kunci: Adaptif, Pesisir, Kualitatif, Teori behaviour

1. Introduction

Global climate change has evolved into one of the most significant challenges faced by humanity in the 21st century. This phenomenon is characterized by an increase in the average temperature of the planet, erratic shifts in weather patterns, and a significant rise in sea level. The impacts of climate change are felt in many parts of the world, but coastal areas are among the most vulnerable to the consequences. This is evidenced by research conducted by Press (2023), which shows that sea level rise can disrupt the balance of coastal ecosystems and even submerge land, especially in areas with low elevation, such as the north coast of Java Island.

Indonesia, the world's largest archipelago with the second-longest coastline, faces enormous risks from ongoing climate change. Coastal areas in Indonesia, especially on the densely populated island of Java, are already experiencing a variety of significant impacts, such as coastal erosion, seawater intrusion, tidal flooding, and changes to marine ecosystems that have a direct impact on the livelihoods of people living in coastal areas. Coastal erosion and tidal flooding are two of the many impacts caused by climate change that are very significant in the northern coastal areas of Java Island. According to research conducted by Ervianto & Hariyanto (2021), sea level rise has caused severe coastal abrasion, especially in areas such as Tambak Raya Beach and Karangsong Beach located in Indramayu Regency, West Java. This abrasion process has destroyed residences, ponds, and tourist facilities, and caused about 2,000 hectares of productive land in Brebes Regency to sink and be submerged by sea water.

The North Coast of Java is an area that has become the focus of significant attention, due to the high level of population density and the high intensity of economic activity that occurs within the region. Based on census data conducted in 2020, it was revealed that the population in regencies and cities located on the north coast of Java reached 50.4 million individuals. In contrast, in the southern region, the population was only recorded at 31.4 million. In terms of population density, the north coast region shows a striking figure of 1,720 people per square kilometer. This figure reflects a condition that is almost three times the population density recorded in the southern region, which only reaches 657 people per square kilometer.

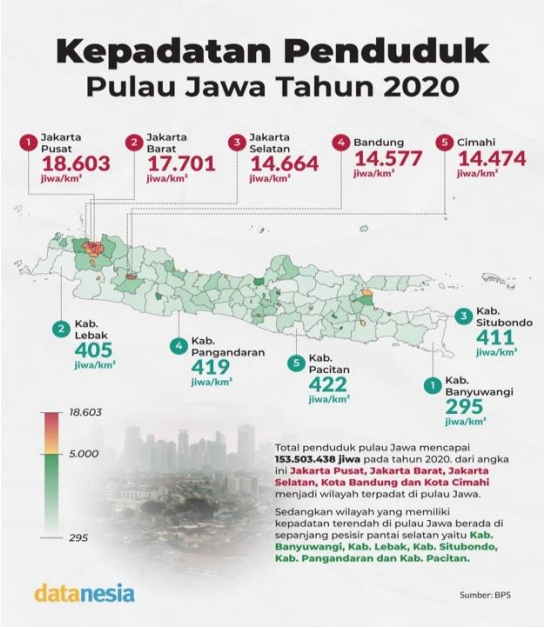

Figure 1. Population Density on the Island of Java in 2020
Source: https://datanesia.id/pulau-jawa-yang-miring-ke-utara/

The region not only includes a number of major cities that are centers of trade and industrial activities, but also includes important ports that play a crucial role in supporting local and regional economic activities. In addition, the region is home to millions of people who are directly dependent on coastal and marine resources, such as fishing, tourism and agriculture.

However, the phenomenon of climate change has posed a serious threat to the sustainability of people's lives in the region, forcing them to make various adjustments and adaptations to changing and uncertain environmental conditions. In the face of various challenges faced, people living in coastal areas have shown a number of forms of behavior that can be categorized as adaptive. Adaptive is a trait or ability to adjust to environmental changes or new conditions (Magfiroh, 2023). In the context of coastal communities, adaptive means that these communities are able to change their behaviors, habits, or even social systems to survive and thrive in an environment that is often dynamic and full of challenges.

This adaptation process includes a series of significant changes in their farming and fishing practices, as well as modifications to existing building structures to adapt to changing environmental conditions. In addition, the community also relocated their residence to avoid the negative impacts of these changes, diversified their livelihoods to improve economic resilience, and initiated various environmental conservation efforts aimed at maintaining and preserving the natural resources around them. However, the effectiveness and sustainability of the adaptive behaviors exhibited by these communities is still an issue that requires further and in-depth research to provide a comprehensive understanding of the impacts and implications of the steps taken.

Research on the adaptive behavior of coastal communities is very important, not only to understand how local communities respond to climate change, but also to design more effective and targeted adaptation policies and strategies. Analysis of these behaviors can provide valuable insights into how local communities understand and respond to environmental risks, and the factors that influence their decisions to adopt particular adaptation strategies. Behavioral theories, particularly those developed by B.F. Skinner, offer a useful framework for analyzing these adaptive behaviors in greater depth. The behaviorist approach proposed by Skinner emphasizes how individuals' behavior is shaped and influenced by the consequences of their actions, which is particularly relevant in the context of adaptation to climate change, which is becoming increasingly urgent. This theory can provide a clear explanation as to why some adaptation strategies are widely adopted by communities, while others tend not to gain the same acceptance, as well as how positive and negative reinforcement play a role in influencing the sustainability of adaptive behaviors undertaken by communities.

This study will focus on an in-depth analysis of the North Coast of Java, an area that reflects the complexity of the challenges posed by climate change in Indonesia. Through an analysis of the adaptive behavior of communities in several locations along the coast, this study seeks to identify patterns of adaptation that emerge in this dynamic context, as well as factors that can influence the success of adaptation, and barriers faced by communities in implementing the adaptation process. A deeper understanding of the adaptive behavior exhibited by coastal communities is expected to not only enrich the academic literature related to adaptation to climate change, but also have important practical implications. The findings of this research are expected to provide valuable input for policy makers in designing more effective and locally relevant adaptation programs, as well as for non-governmental organizations and international agencies involved in climate change adaptation issues in coastal areas.

2. Method

This research adopts a qualitative approach combined with a systematic literature study method, aiming to analyze the adaptive behavior exhibited by coastal communities in the face of various climate changes occurring on the North Coast of Java. The reason for using qualitative methods in research is because qualitative methods emphasize the observation of phenomena and examine more into the substance of the meaning of the phenomena that occur so that the impact of climate change felt by coastal communities can be analyzed more sharply and deeply. The choice of systematic literature study was made because this approach has the capacity to integrate and synthesize findings from various sources of information thoroughly, which is very suitable for the limited time and resources available in the context of this research. The data collection process was carried out through an in-depth search of scientific journal articles, textbooks, research reports and policy documents relevant to the topic under study. These sources were accessed through various academic databases, including but not limited to Google Scholar, JSTOR, and ScienceDirect, as well as local repositories managed by universities and research institutions in Indonesia. In the search process, keywords used included terms such as “adaptive behavior,” “climate change,” “coastal communities,” “North Coast of Java,” and combinations of these terms in both Indonesian and English.

Inclusion criteria for the sources used in this study included: (1) publications released within the last ten years to ensure relevance and accuracy to current conditions, (2) a primary focus on adaptive behaviors exhibited by coastal communities in the context of climate change, (3) an emphasis on the Indonesian geographical context, particularly with regard to the North Coast of Java, and (4) the existence of a clear and justifiable research methodology. Sources that do not meet these criteria will not be included in the analysis.

Data analysis was conducted through the application of thematic content analysis method, which is a systematic approach to understanding the meaning behind qualitative data. This analysis process consists of several interrelated stages, namely: (1) reading deeply and thoroughly all sources of information that have been collected to understand the broader context, (2) identifying the main themes that emerge and relate to adaptive behavior, (3) categorizing the findings based on these themes to facilitate further analysis, (4) analyzing patterns and trends that emerge from the categorized data, and (5) synthesizing the findings to provide comprehensive answers to the research questions that have been raised.

To ensure the validity and reliability of the data obtained, this study applied source triangulation, where findings were compared with different types of information sources, such as scientific journals, books and research reports, and considered perspectives from different disciplines such as sociology, ecology and marine science. In addition, the analysis process also involved peer debriefing, involving other researchers to provide constructive feedback, in order to reduce bias and increase objectivity in data interpretation.

The theoretical framework used in this analysis refers to the behavioral theory proposed by B.F. Skinner, especially with regard to the concept of operant conditioning. This theory is used as an analytical lens to understand how adaptive behaviors exhibited by coastal communities are formed and reinforced by consequences arising from the environment and social interactions. The main focus of this analysis is on identifying relevant environmental stimuli, such as climate change, behavioral responses taken by the community, in the form of adaptation strategies, as well as the consequences faced, both success and failure in the adaptation process, which ultimately form the observed adaptive behavior patterns.

The limitations of this method of analysis are recognized, particularly with regard to the lack of primary data generated from direct interviews or field observations that could provide more in-depth context. Nonetheless, by utilizing comprehensive and up-to-date secondary sources, this research seeks to present an in-depth and useful analysis of the adaptive behavior of coastal communities living on the North Coast of Java in the face of challenges posed by ongoing climate change.

3. Result and Discussion

Analysis of the adaptive behavior of coastal communities in the North Coast of Java in the context of climate change can be done with a more in-depth approach using the theory of behavior proposed by B.F. Skinner, especially in the aspect of operant conditioning. This theory states that individual behavior is shaped and influenced by the consequences that follow the action, a concept that is very relevant and applicable in understanding how communities adapt to changes that occur in their environment. First of all, the formation of adaptive behavior can be seen as the result of an ongoing process of operant conditioning. Climate change, which includes phenomena such as sea level rise and changes in weather patterns, acts as an environmental stimulus that prompts communities to provide adaptive responses. As a concrete example, the increasing frequency of tidal flooding in the area has encouraged coastal communities to modify the structure of their houses, such as by raising the floor of the house or building embankments to protect themselves from flood risks (Bariroh & Surtikanti, 2024). In addition, a study conducted by Lahay (2020) in Ilodulunga Village, North Gorontalo Regency, showed that the local community has identified the presence of flooding Mangrove forests are one of the dominant forms of land use and are critical in adapting to the impacts of climate change. Success in implementing these adaptive strategies, which have proven effective in reducing the impacts of flooding, serve as positive reinforcers that increase the likelihood of these adaptive behaviors being repeated and adopted more widely among coastal communities.

The concept of operant reinforcement in Skinner's theory provides a strong framework for understanding variations in the adoption of adaptive behaviors among coastal communities facing climate change. Case studies on the north coast of Java show that adaptation strategies that generate immediate and concrete primary reinforcers, such as increased income from livelihood diversification, tend to be adopted

more quickly and widely. According to Qonita (2023) communities on the north coast of Java have adopted livelihood diversification strategies in response to climate change and land subsidence. For example, farmers in Timbulsloko Village have switched from growing rice to crops that are more resilient to extreme conditions, such as maize and cassava, which provide more stable yields and increase their income. This is in line with the principle of positive reinforcement, where behaviors followed by pleasant consequences tend to be repeated. In contrast, adaptation strategies that involve secondary reinforcers or delayed reinforcers. Take mangrove conservation for example. Natural regeneration of mangroves and enhancement of mangrove ecosystems takes several years to decades to reach optimal conditions. This makes it difficult for communities to see the immediate benefits of conservation efforts, so motivation to continue the practice may decrease.

Figure 2. Previous Magrove Growth
Source: Tempo.com

The challenges faced in this context are further exacerbated by a number of additional factors, including low levels of community awareness, limited available resources, and social pressures that tend to encourage less sustainable behavior. Research conducted by Kandari (2021) and Dewi (2023) shows that there are many instances where local communities resist mangrove ecosystem rehabilitation initiatives. The rejection is often due to the perception that land that should be used for mangrove conservation has higher economic potential if allocated for other activities, such as aquaculture or plantation development. Furthermore, the decision to reject rehabilitation is usually rooted in the prioritization of short-term economic needs that are perceived to be more urgent, compared to the potential long-term benefits that can be obtained through mangrove ecosystem conservation efforts.

The principle of shaping, or gradual formation, proposed by B.F. Skinner, can be observed in the development of adaptive behavior carried out by coastal communities facing the challenges of climate change. Adaptation to climate change does not happen suddenly, but rather through a series of small, progressive changes, each of which gets closer to the most optimal response. For example, fishermen operating on the north coast of Java Island may start to make adjustments to their fishing time, in order to avoid extreme weather or dangerous high waves (Sumolang, 2023). This is directly proven by the incident in Semarang, precisely in Tambaklorok Village, where many fishermen have stopped going to sea due to very high waves and strong winds (Detik.com, 2024). A fisherman, Darmadi, mentioned that they had not been able to go to sea for almost a week due to these dangerous conditions.

Figure 3. Interview with Mr. Darmadi
Source: Detik.com

After experiencing the benefits of the changes implemented, the fishermen then switched to using more efficient as well as environmentally friendly fishing gear, such as the application of more selective nets, with the aim of minimizing the catch of unwanted fish. This finding is supported by research conducted by Barus & Septaria (2023), which showed that fishers in Cilacap have shifted to more sustainable fishing methods to prevent exploitation of fisheries resources. The study revealed that the measures taken include the implementation of a select catch system as well as the use of fishing gear such as gill nets and trammel nets, which do not cause damage to the seabed ecosystem. The design of gill nets allows for selective fishing, reducing unwanted catch while preserving fish stocks for the future. In addition, fishers can also diversify their businesses, for example by shifting focus to fish farming in ponds or developing the marine tourism sector as an additional source of income (Ginting, 2022). Each step taken has the potential to generate positive impacts, such as increased income and resource sustainability, which in turn contribute to the formation of increasingly complex adaptive behaviors over time. Through this mechanism, coastal communities can not only adapt to the challenges posed by climate change, but also strengthen their economic and social resilience through a gradual and consistent learning process.

The concept of punishment in Skinner's theory is also relevant in understanding the reduction of maladaptive behavior. Economic loss or physical damage resulting from unsustainable practices acts as a natural punishment, reducing the likelihood of the behavior being repeated. For example, if fishermen continue to use destructive fishing methods, such as bomb or poison fishing, they may face declining catches as fish populations decline (Firmansyah, 2020). This is also supported by Public Info ID, which reports the declaration of fishermen in Prajak Hamlet, NTB, to stop using fish bombs and poisons. This declaration is supported by KKP's policy to encourage fishing using environmentally friendly methods. This step is expected to preserve marine biota and increase awareness of coastal communities about the importance of bypassing destructive fishing practices.

The financial loss resulting from this decrease in catch acts as a natural punishment, which reduces their likelihood of repeating the behavior in the future (Amar, 2021). In addition, the environmental damage caused by unsustainable fishing practices can lead to habitat and biodiversity loss, which in turn negatively impacts the marine ecosystem. When fishers realize that their actions not only harm fish resources but also threaten their own livelihoods, they are more likely to switch to more sustainable fishing methods.

The inter-regional variation of adaptive behavior in the North Coast of Java can be explained through Skinner's concept of environmental context, which asserts that individuals' behavior is strongly influenced by the environmental conditions in which they find themselves. To illustrate, fishers in more developed areas such as Semarang tend to be more responsive to the use of environmentally friendly fishing technologies, as they receive support from the local government and have access to adequate training and resources. On the other hand, fishers in more remote areas, such as Jepara Regency, may still rely on traditional fishing methods that are potentially damaging to the environment, due to limited access to information, training and adequate infrastructure.

These differences in the social and economic conditions of each region create different environmental contexts for behavior formation and conditioning, so adaptation strategies that work in one region may not always work effectively in another. For example, a training program for the use of sustainable fishing gear

may prove effective in increasing catches in the Semarang region, but implementation of a similar program in the Jepara region could be less successful if fishers in that region do not have access to sufficient markets or financial support to adopt new and more efficient fishing gear.

Although the study findings as part of the adaptation process identified delayed reinforcement, particularly in relation to mangrove conservation, it must be recognized that coastal communities' decisions are not solely determined by rewards or outcomes resulting from direct interactions with the environment. Municipalities also face a dilemma between short-term economic needs, such as the consequences of intensive fishing and land use activities, and the long-term ecological benefits achieved by maintaining coastal ecosystems such as mangroves. The interplay between short-term economic needs and long-term environmental benefits plays an important role in the design of adaptive behavior. For example, some fishers and pond farmers may know the benefits of mangrove conservation, but they will implement land conversion due to daily economic requirements. This shows that adaptation is not only a matter of response to reinforcement, but also a matter of negotiating future value, risk and effort.

Furthermore, the operant conditioning theory in this study on the main analytical framework describes communities as responding to environmental stimuli. However, in the context of adaptation to climate change, it is important to consider the active role of communities as agents of change. Many examples show that communities not only passively adapt, but also generate local innovations, form social institutions, and make collective decisions based on experiences, cultural values and local knowledge. For example, in some coastal areas of Java, and community initiatives such as mangrove rehabilitation, local policy briefings based on local weather forecasts, or the establishment of rotating planting systems, have shown positive aspects of coordination. Therefore, adaptation is understood not only as the result of external reinforcement, but also as a process involving social learning, creativity and collective agency.

4. Conclusion

Global climate change is one of the biggest challenges faced by humanity, especially for coastal areas that are highly vulnerable to its impacts. The North Coast of Java, as an area with high population density and a significant center of economic activity, has experienced serious impacts, such as coastal abrasion, tidal flooding, and seawater intrusion into inland ecosystems. Previous research has shown that sea level rise poses a threat to the sustainability of coastal ecosystems, while disrupting the livelihoods of communities dependent on marine resources. Coastal communities in this region have adapted to environmental changes through a number of strategies, including modifying building structures, changing patterns of agricultural and fisheries practices, and diversifying their economies. However, the effectiveness of these adaptive behaviors varies depending on several factors, such as government support, access to adequate information, and the level of awareness of environmental issues. In this context, the behavioral theory developed by B.F. Skinner provides an understanding of how adaptive behavior can be formed through positive and negative reinforcement mechanisms. Adaptation strategies that provide immediate results, such as livelihood diversification, tend to be more readily accepted by communities. In contrast, conservation measures with long-term benefits, such as mangrove rehabilitation, are often less desirable. This research emphasizes the importance of developing adaptation policies that are more contextualized and supported by approaches that are aligned with local conditions. The implementation of such adaptation policies needs to take into account social, economic and resource access differences across regions to ensure the resilience of coastal communities in the face of climate change impacts.

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