



Social-ecological resilience of coastal tourism to climate change: A case study of Depok Beach, Bantul, Indonesia

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Abstract

Purpose – The sustainability of coastal tourist destinations, such as Bantul's Depok Beach, is significantly impacted by climate change. The socio-ecological resilience of coastal communities as well as the adaptation and mitigation techniques created to deal with the risks of abrasion and extreme weather are the subjects of this study.

Methodology/Design/Approach – Through documentation studies, in-depth interviews, and field observations, the research methodology employed descriptive qualitative approaches. Fishermen, traders, and managers of tourism awareness groups (Pokdarwis) were among the key informants.

Findings – The findings indicate that cross-sectoral cooperation with the government and educational institutions, local organization strengthening, and economic resource diversification all contribute to the development of socio-ecological resilience. Reforestation programs, disposal of waste, and the implementation of eco-friendly tourism practices are all a component of mitigation efforts. Conversely, adaptation happens through modifications to corporate policies, innovations in digital marketing. Conversely, adaptation is achieved through modifications to corporate procedures, advancements in digital marketing, and readiness for abrasion effects. These results highlight how crucial it is to combine social, economic, and ecological factors in order to increase coastal communities' and tourism's resilience to climate change

Originality/value – This study uniquely integrates socio-ecological resilience with practical adaptation and mitigation strategies in coastal tourism sustainability. Focusing on Depok Beach, Bantul, it highlights local collaboration among communities, government, and academia, while introducing digital marketing innovation as an adaptive response to climate challenges. The research contributes an integrative model linking ecological sustainability with socio-economic resilience in coastal destinations.

Keywords: socio-ecological resilience, coastal tourism, climate change, adaptation, mitigation

Introduction

Global climate change has produced a number of significant impacts on coastal regions (Berhиту et al., 2025). Variations in rainfall patterns have disrupted freshwater availability and reduced fishing productivity, while rising sea surface temperatures have accelerated coastal erosion and contributed to sea-level rise. These phenomena not only threaten the sustainability of coastal ecosystems but also expose communities that depend on marine resources to serious socioeconomic risks. Consequently, these environmental shifts disturb the balance between tourism development, local economic stability, and coastal environmental conservation in destinations such as Depok Beach.

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Beyond environmental aspects, climate change exerts a profound influence on the tourism industry. The degradation of beach aesthetics due to abrasion, damage to tourism infrastructure from high waves, and reduced visitor comfort caused by extreme weather conditions have become new challenges for destination sustainability (Aikins, 2024). This situation directly affects the livelihoods of local communities as particularly traders, fishers, and tourism entrepreneurs whose income relies heavily on visitor arrivals ((IPCC), 2023). Without effective adaptation strategies (Onyekuru et al., 2024), these adverse changes could reduce destination competitiveness and threaten the economic security of coastal residents.

To confront these challenges, coastal communities must enhance their socio-ecological resilience (Folke et al., 2010; Subramaniam et al., 2023). Such resilience encompasses the capacity to innovate in resource management, adapt to environmental changes, and strengthen local institutions and social networks. Collaborative efforts among residents, local authorities, tourism stakeholders, and community-based tourism organizations (Pokdarwis) are essential for conserving coastal ecosystems and promoting sustainable tourism practices at Depok Beach. In light of the ongoing threats posed by global climate change, a socio-ecological resilience-based approach offers a strategic pathway to maintain equilibrium between environmental preservation and economic sustainability.

The impacts of climate change also affect tourist visitation patterns, destination attractiveness, and the sustainability of local businesses (Song, 2023). This study expands this concept by examining the socio-ecological dynamics of the Depok Beach community in the local Indonesian environment. Coastal abrasion, reduced fisheries production, and disturbances to the socioeconomic activities of communities reliant on coastal resources, especially tourism, are only a few of the effects of changes in the coastal environment (Balsalobre-Lorente et al., 2023; Ramaano, 2025). This impact is not only physical but also extends to the social and cultural realms (Jaspal et al., 2014; Kostis & Kafka, 2023). Communities are being forced to modify their work schedules and means of subsistence due to unpredictable weather, changing fishing seasons, and diminishing marine supplies. Due to competition for fewer and fewer resources, this could eventually lower well-being, change livelihood arrangements, and raise societal pressure.

Reduced visitor numbers, deteriorating infrastructure, and the decline in natural aesthetics illustrate how climate change is profoundly impacting coastal areas (Daraz et al., 2024) such as Depok Beach, which rely heavily on tourism. Local tourism businesses have experienced substantial financial losses due to coastal erosion and the increasing frequency of sea storms factors that have diminished both the accessibility and visual appeal of these destinations. Beyond reshaping the physical landscape, these environmental disruptions also destabilize the socioeconomic systems that sustain local livelihoods.

This phenomenon highlights that, for coastal communities whose survival depends on the integrity of natural systems, climate change represents a complex socio-economic challenge that extends far beyond ecological concerns. The interdependence between community welfare and environmental degradation creates a vicious cycle of vulnerability, where declining environmental quality reduces tourism potential, thereby threatening social stability and local income. Addressing climate change in such contexts therefore requires an integrated approach—one that combines environmental management with social, cultural, and economic adaptation strategies.

Building strong socio-ecological resilience is essential for coastal communities to withstand these multifaceted pressures (Subramaniam et al., 2023). Such resilience reflects the community's capacity to adapt, reorganize, and innovate in response to environmental changes while maintaining the essential functions of their social and ecological systems (Woodburn et al., 2025). By diversifying income sources, applying local knowledge, and implementing community-based resource management, coastal communities can strengthen their ability to cope with climate-induced challenges.

In this context, collaboration among government institutions, community-based tourism organizations such as Pokdarwis, local residents, and tourism entrepreneurs becomes crucial. These partnerships foster shared responsibility, support adaptive governance, and ensure the simultaneous achievement of environmental conservation and economic sustainability. Through the application of a socio-ecological resilience framework (Subramaniam et al., 2023), coastal destinations like Depok Beach can pursue a more

balanced and sustainable pathway one that safeguards the ecological integrity of coastal ecosystems while enhancing the well-being of local communities (Sari & Putri, 2025).

In this context, a study on the socio-ecological resilience of tourism at Depok Beach becomes highly relevant. Understanding the adaptation and mitigation strategies implemented by communities and tourism operators can provide insights into how social and ecological systems mutually reinforce each other in the face of climate change impacts. Additionally, this study is expected to serve as a reference in formulating sustainable tourism development policies in Indonesia's coastal areas.

Method

This study uses a qualitative approach to deeply (Cajee, 2014) understand the forms of social ecological (Almar et al., 2021; Shah et al., 2025) resilience among coastal communities and tourism stakeholders at Depok Beach in responding to the impacts of climate change and coastal abrasion. This approach was chosen because it allows researchers to explore the community's experiences, perceptions, and adaptation strategies in a contextual and comprehensive manner. The type of research used is descriptive qualitative (Furidha, 2024; He et al., 2024; Rony et al., 2024) , which aims to describe social reality as it is based on the interpretation and meaning-making of the informants.

The research subjects and informants include coastal communities and tourism stakeholders, such as fishermen, traders, warung managers, members of Pokdarwis (Community-Based Tourism Groups), as well as village officials or tourism area managers. Informants were selected using purposive sampling techniques with the following criteria: a) Residing in Depok Beach for at least three years, b) Actively involved in economic and social activities in the coastal area, and c) Possessing knowledge of the dynamics of coastal environmental change. The number of informants grew thru snowball sampling until sufficient data was obtained and saturation point was reached.

Data Collection Techniques, using three main methods: participatory observation, to observe community behavior, tourism activities, and the physical condition of the beach affected by abrasion. Then, in-depth interviews were conducted using a semi-structured guide to explore the community's narratives of experience and adaptation strategies to climate change. Additionally, documentation was gathered, including photos, erosion maps, local policy data, and secondary documents related to coastal management and tourism.

The main instrument of this research is the researcher as the key instrument (human instrument) directly involved in the entire research process, from planning to drawing conclusions. Researchers used interview guides, field notes, audio recordings, and VenSim software as tools to help model the relationships between social and ecological variables.

Using VenSim, data analysis procedures are carried out interactively and concurrently with dynamic system modeling (System Dynamics)(Sundiman & Satyani, 2024). Integrating qualitative analysis with a System Dynamics approach aims to identify key variables, trace cause-and-effect relationships, and simulate dynamic adaptation mechanisms within coastal social-ecological systems. This approach helps understand how changes in ecological aspects (abrasion as a result of extreme weather) affect the social and economic conditions of the community, and how the community adapts to maintain livelihoods and tourism sustainability.

Findings and discussion

Results of model interpretation using the Vensim dynamic system

The condition of abrasion in relation to social conditions

Coastal abrasion directly and profoundly affects the social conditions of coastal communities. The erosion of shorelines often results in the loss of settlements, damage to public facilities, and the reduction of communal spaces that foster social interaction. These changes disrupt residents' daily lives and threaten the social cohesion that binds coastal societies together.

As abrasion intensifies, social stability tends to deteriorate. Communities struggling to adapt to the loss of land and infrastructure face increasing ecological and social pressures. The displacement of residents,

destruction of public spaces, and decline in collective activities heighten feelings of insecurity and weaken social solidarity.

Research indicates that coastal abrasion not only alters the physical characteristics of coastal areas but also exerts significant social impacts on populations whose livelihoods depend on coastal resources. The combined effects of losing homes, damaged infrastructure, and diminishing social spaces lead to the erosion of both physical settlements and the socio-cultural environments that sustain local identity and economic life.

Abrasion's Effect on the Economy of the Community

Abrasion also reduces the income of communities that depend on coastal resources (fishermen, traders, tourism operators). This decline creates economic uncertainty and lowers well-being. Coastal abrasion has a real impact on the economies of coastal communities, particularly for those whose livelihoods depend on the utilization of marine resources and tourism activities. The fishermen experienced a decline in their catch due to the shrinking fishing grounds and the destruction of coastal ecosystems such as mangroves and coral reefs, which are fish habitats. Traders around the beach area were also affected because they lost their selling locations and the number of visiting tourists decreased. For tourism operators, abrasion reduces the attractiveness of coastal areas as recreational destinations, thereby decreasing the number of visitors and revenue. This situation leads to economic instability, increased risk of job loss, and a decline in the well-being of coastal communities. In the long term, this impact can weaken local economic resilience and increase community vulnerability to poverty.

Social Conditions in Relation to the Community's Economy

Deteriorating social conditions can weaken the economic capacity of communities, for example, due to declining social solidarity or increasing conflict over dwindling resources (Adjei-Mensah & Kusimi, 2020; Boersema, 2015; Nkhonjera, 2017). The damage to social conditions in coastal areas due to abrasion has an indirect but significant impact on the economic activities of the community. The weakening of social solidarity results in a decline in the spirit of mutual cooperation and community collaboration in addressing environmental issues. In fact, this value of togetherness is important for supporting local economic activities such as fishing, tourism businesses, and small trading activities around the beach.

Social Conditions in Relation to Sustainable Living and Tourism

When social conditions are stable and society supports each other, efforts to maintain tourism sustainability will be stronger (Abbass et al., 2022). Social stability plays an important role in maintaining the sustainability of life and tourism activities in coastal areas. When society is in a harmonious social condition, with mutual trust and a strong spirit of cooperation, they are better able to work together to protect natural resources, maintain environmental cleanliness, and create a conducive atmosphere for tourists. This social strength also increases the community's ability to withstand and adapt to environmental threats such as abrasion or climate change. Conversely, if social conditions are disrupted, the sustainability of tourism activities is also threatened.

Abrasion's Effect on the Economy of the Community

Economic pressure is forcing towns to adjust, for instance by looking for new revenue streams, creating new tourism enterprises, or fostering greater community collaboration. The community is now undergoing adaptation attempts as a result of the economic strain brought on by diminishing income and scarce coastal resources. Communities are looking for alternate sources of income in order to survive, such as establishing new service-related enterprises, boosting local tourism, or making more creative and sustainable use of the environment's potential. Conversely, economic hardships can also deepen social ties by encouraging more citizen solidarity and cooperation, both through cooperative business organizations and cooperation with the government and other institutions of assistance. Economic pressure can also serve as a catalyst for.

However, via more citizen solidarity and cooperation both through cooperative business groupings and cooperation with the government and other institutions of support economic hardships can also deepen social

ties. Economic pressure can therefore serve as a catalyst for constructive change that encourages innovation and fortifies coastal communities' socio-ecological resilience.

Communities Adjusting to Eco-Friendly Tourism and Lifestyle

One important component of preserving sustainability is the community's capacity for adaptation. Even when erosion persists, economic and tourism sustainability can be preserved when the community can adjust to changing circumstances. In coastal locations, the ability of the community to adapt is crucial to preserving both the tourism industry and the sustainability of life. Communities can sustain economic activity and the sustainability of tourism by modifying their social behavior and methods in response to environmental changes and the effects of abrasion.

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The direct abrasion of adaptive communities

The local community must quickly adjust to the pressure of abrasion, whether it be through innovative business practices, changes in work schedules, or environmental mitigation. Coastal towns are directly forced to adapt in order to live due to the environmental strain brought on by abrasion. Work schedule adjustments, livelihood adjustments, the creation of new company structures better suited to the environment, and mitigation measures to lessen the effects of abrasion are some examples of this adaptive response.

In other words, because people are motivated to develop practical adaptation measures to guarantee the sustainability of life and economic activity in coastal areas, abrasion acts as a significant catalyst for the creation of innovation and socioeconomic transformation within communities.

The outcomes of the System Dynamics modeling process with Vensim are as follows:

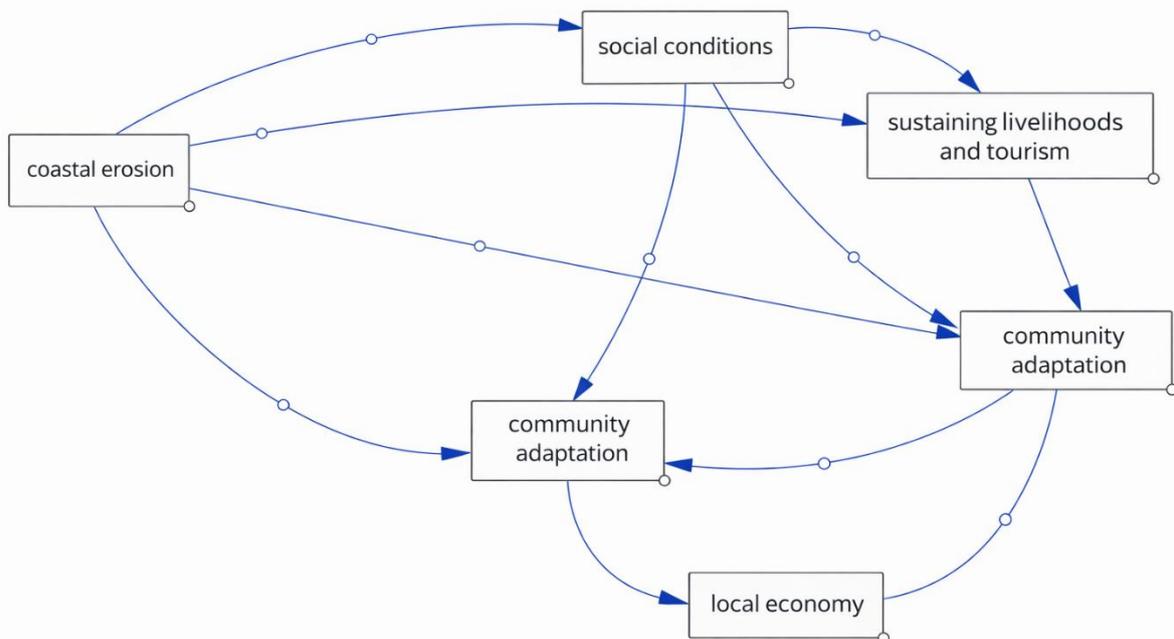


Figure 3. Social-Ecological Resilience of Coastal Tourism to Climate Change: A Vensim Approach to System Dynamics Modeling. Source: Author's field work, 2025

According to this concept, abrasion is the first cause of disturbance; nevertheless, the social, economic, and adaptive capacities of communities demonstrate their socio-ecological resilience, which is essential for preserving livelihoods and the sustainability of coastal tourism.

Explanatory Relationships in Adaptive Systems

The two primary relationship types depicted in this model are positive (reinforcing) and negative (balanced) loops. The Social-Ecological System's Reaction to Abrasion has lowered welfare levels and deteriorated social and economic situations, but it has also forced communities to adapt (Ramaano, 2025). Indirectly lessening the effects of abrasion, effective adaptation allows communities to modify their economic and lifestyle practices in response to shifting environmental conditions. The potential of socio-ecological systems to self-stabilize through adaptation processes is demonstrated by this outcome, which acts as a balancing mechanism.

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Conclusion

Overall, the VenSim modeling results show that abrasion is an external force that significantly strains coastal communities' social and economic systems. However, socio-ecological resilience, which is demonstrated by the community's capacity to adjust to environmental shifts, has allowed it to preserve the sustainability of local tourism and life.

These results demonstrate the importance of community adaption strategies in mitigating the adverse effects of abrasion. Thus, this model can serve as a guide for developing coastal development policies that prioritize adaptive, participatory, and sustainable methods in addition to being sensitive to changes in the environment.

Acknowledgment

Not applicable.

Declaration

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

The data supporting the findings of this study are available upon request.

Competing interests

The authors declare that there is no conflict of interest regarding this work.

Declaration of generative AI and AI-assisted technologies

During the preparation of this work the author used Grammarly in order to correct spelling mistakes and help me make better sentences. After using this tool/service, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

Author contributions

IPHHD, RS, and WAA Conceptualization, Methodology, Investigation, Writing – original draft. PTC, MM, NB, and AA Data curation, Formal analysis, Validation, , Supervision.

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