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Resilience and Vulnerability of Coastal Communities: A Case Study of Tambak Lorok, Semarang-Indonesia in Facing Flood Risks

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Abstract

This study examines the resilience and vulnerability of the Tambak Lorok coastal community in Semarang to recurring flood events. The research adopts a descriptive qualitative approach to explore the socio-economic, environmental, and infrastructural aspects influencing the community's adaptive capacity. Through in-depth interviews, field observations, and document analysis, the study identifies key factors contributing to the community's vulnerability, including reliance on flood-prone economic activities, inadequate housing infrastructure, and limited access to resources. The role of local institutions is also highlighted as a critical factor in enhancing community resilience through training and support programs. Despite ongoing mitigation efforts, such as the construction of levees and drainage improvements, the findings indicate that these measures have not fully protected the community from flood impacts. The study concludes with policy recommendations aimed at improving infrastructure, diversifying economic activities, and strengthening disaster mitigation strategies to enhance the long-term resilience of the Tambak Lorok community. This research contributes valuable insights into the challenges faced by coastal communities in adapting to the increasing risks posed by climate change and environmental hazards.

Keywords: Resilience, Urban Coastal Areas, Tambak Lorok

Introduction

The application of resilience concepts in urban and environmental studies has provided researchers and policymakers with valuable insights into how communities can withstand and adapt to crises, as well as how strategies can be optimized to reduce vulnerability to disaster risks (Kamal et al., 2018). Resilience, in this context, encompasses not only post-disaster recovery but also the enhancement of a community's capacity to anticipate, respond to, and adapt to ongoing changes. In urban and coastal areas, resilience is often linked to how effectively communities can manage the impacts of natural disasters while maintaining essential socio-economic functions (Wisner, Gaillard, & Kelman, 2012).

Tambak Lorok, a coastal area in Semarang known for its high flood risk, exemplifies the relevance of resilience concepts. The geographic and environmental conditions of Tambak Lorok make it particularly susceptible to flooding, driven by natural factors such as high rainfall intensity, land subsidence, and climate change-

induced sea level rise (Arouri, Nguyen, & Youssef, 2015). Land subsidence in this area, which has been reported to reach several centimeters per year, exacerbates the frequency and impact of floods (Berkes & Ross, 2016). Understanding and strengthening community resilience in this region is thus of paramount importance.

The socio-economic conditions of the Tambak Lorok community further intensify their vulnerability to floods. Many residents rely on sectors that are highly susceptible to disruption, such as fishing and small-scale trading, making them more vulnerable to the adverse impacts of disasters (Cutter, Boruff, & Shirley, 2012). This economic dependency underscores the need for resilience strategies that support both economic and social stability (Tarr-Attia et al., 2018). Research indicates that socio-economic resilience in coastal areas like Tambak Lorok depends on the community's ability to access adequate resources, maintain supportive social structures, and develop effective adaptation strategies (Cutter, Burton, & Emrich, 2010). However, this resilience is often contingent on economic stability, as floods can severely disrupt livelihoods (Danzer & Dietz, 2018).

Environmental resilience also plays a critical role in mitigating flood risks in coastal communities. It refers to the ability of ecosystems to maintain their functions despite pressures or disturbances, including those caused by human activities and climate change (Klein, Nicholls, & Thomalla, 2003). Efforts to enhance environmental resilience in Tambak Lorok have included disaster mitigation measures such as the construction of levees and improvements to the drainage system (Farida, 2021). However, the effectiveness of these measures still requires thorough evaluation, particularly in the context of sustainable natural resource management and community participation in disaster mitigation (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008).

Despite significant progress in understanding coastal community resilience, gaps remain in how localized institutional support can effectively mitigate vulnerabilities in highly flood-prone areas (Shaw, 2019). Previous research has highlighted the need for comprehensive evaluations of existing mitigation strategies to determine their effectiveness and identify areas for improvement (O'brien, Eriksen, Nygaard, & Schjolden, 2007). Moreover, while communities like Tambak Lorok have demonstrated strong social resilience through adaptive strategies such as building stilt houses and altering cropping patterns, challenges persist in maintaining long-term economic resilience and environmental sustainability.

This study aims to comprehensively analyze the resilience of the Tambak Lorok community to recurrent flooding and assess the effectiveness of the mitigation programs that have been implemented in the area. By evaluating both community resilience and the success of these programs, the study seeks to generate insights that can inform more effective policies and strategies for managing flood risks in coastal areas. Ultimately, the goal is to enhance the protection and preparedness of vulnerable communities against the increasing threats posed by climate change and environmental challenges.

Research Method

This study employs a descriptive qualitative research approach to explore and analyze the resilience of the Tambak Lorok community to flooding. The qualitative methodology was chosen due to its suitability for understanding complex socio-environmental dynamics, allowing for an in-depth exploration of adaptive strategies employed by residents. The methodology includes the type of research, location and subjects of the study, data collection techniques, data analysis methods, and an evaluation of mitigation programs within the community. This section provides sufficient detail to enable the reproduction of the analysis.

The study adopts a descriptive qualitative research design, which is ideal for exploring the experiences, perspectives, and adaptation strategies of the Tambak Lorok community in response to floods. This approach also allows the researcher to consider the social, economic, and environmental contexts that influence community resilience.

The research was conducted in Tambak Lorok, a coastal area in Semarang known for its vulnerability to flooding. The subjects of the study include: 1) Local Residents: Individuals living and working in Tambak Lorok, particularly those engaged in vulnerable economic sectors such as fishing and small-scale trading. 2) Local Stakeholders: Community leaders, local authorities, and government officials involved in area management and disaster mitigation. 3) Non-Governmental Organizations (NGOs): Organizations actively participating in disaster mitigation and adaptation programs in the coastal areas of Semarang.

Data were collected using a combination of in-depth interviews, field observations, and document analysis. These methods provide a comprehensive understanding of the resilience of the Tambak Lorok community. Semi-structured interviews were conducted with residents and stakeholders to gather detailed information on their experiences with floods, adaptation strategies, and views on the effectiveness of mitigation efforts. The interviews followed flexible protocols, allowing for the exploration of specific topics based on respondents' answers.

Field observations were conducted to directly observe the physical environment, existing infrastructure, and community activities related to flood management. Participatory observation was employed, wherein the researcher engaged in community activities to gain deeper insights into the socio-economic context influencing resilience. Relevant documents, including government reports, weather data, regional maps, and policy documents, were analyzed to provide additional context and support the data collected through interviews and observations.

The data were analyzed using thematic analysis, following these steps: 1) Data Transcription: Interviews were transcribed verbatim to ensure accuracy. 2) Coding: The transcribed data and observational notes were coded to identify recurring themes. 3) Thematic Analysis: The coded data were analyzed to identify themes related to social, economic, and environmental resilience in Tambak Lorok. 4) Interpretation: The themes were interpreted within the framework of resilience theory and the specific conditions in Tambak Lorok.

To ensure the validity and reliability of the findings, triangulation techniques were employed by cross-referencing data from interviews, observations, and document analysis. Additionally, member checking was conducted by asking respondents to review the interview transcripts or preliminary findings to ensure the researcher's interpretations accurately reflected their experiences (Cutter et al., 2010).

This study acknowledges several limitations, including the time constraints that limited long-term observation of changes in community resilience. As a qualitative study, the findings are specific to Tambak Lorok and may not be generalizable to all coastal communities in Indonesia. However, the insights provided are valuable for informing further research and policy formulation.

Result and Discussion

Socio-Economic Conditions of the Tambak Lorok Community

The socio-economic fabric of Tambak Lorok is predominantly shaped by the livelihoods of its residents, who are primarily engaged in fishing and small-scale trading. These activities are highly susceptible to disruption by frequent and intense flooding. The research found that when floods occur, many residents are unable to fish or trade due to polluted water and unsafe conditions, leading to significant income loss.

Fig. 1 (a) The Tambak Lorok neighbourhood shows the aftermath of flooding, with waterlogged streets and debris. (b) Residents repairing their homes after the flood, reinforcing walls and roofs. Source: (Field documentation, June 2024)

Table 1. Socio-Economic Impact of Flooding on Tambak Lorok Community (June 2024)

Category	Impact Description
Economic Disruption	Inability to fish due to polluted water and high waves during floods, leading to income loss.
Housing Damage	Significant damage to homes made of bamboo and wood, requiring costly repairs.

Increased Vulnerability	High reliance on fishing, with limited economic diversification, exacerbating financial risks.

From the perspective of economic resilience theory, a community's ability to maintain its core economic functions and adapt to environmental challenges is crucial (Martin & Sunley, 2015). In Tambak Lorok, the heavy reliance on fishing and trading underscores weak economic resilience. The lack of alternative livelihoods exacerbates the community's vulnerability when their primary income sources are disrupted. Additionally, the financial burden of repairing flood-damaged homes further deepens socio-economic vulnerability (Arouri, Nguyen, & Youssef, 2015). This situation highlights the urgent need for income diversification to build greater economic resilience.

Post-Flood Housing Conditions

The physical condition of housing in Tambak Lorok is a critical factor in the community's vulnerability to flooding. The research revealed that many homes are constructed from materials such as bamboo and wood, which are not resilient to water damage. As a result, floods often cause significant structural damage, including cracked walls, displaced roofs, and eroded foundations.

Table 2. Post-Flood Housing Damage in Tambak Lorok (June 2024)

Type of Damage	Description
Structural Damage	Cracked walls, damaged roofs, and eroded foundations in houses made of bamboo and wood.
Environmental Contamination	Mud and debris brought into homes by floodwaters, requiring extensive clean-up efforts.
Temporary Displacement	Many residents sought temporary shelter due to the severity of housing damage.

Fig.2 The condition of a Tambak Lorok resident's house severely damaged by flooding, with cracked walls and a damaged roof. Source: (Field documentation, June 2024).

Environmental resilience theory emphasizes that the quality of infrastructure plays a significant role in a community's ability to withstand and recover from

environmental disturbances (Hunt & Harbor, 2019). In Tambak Lorok, the persistent use of non-durable materials and the lack of flood-resistant construction practices contribute to repeated damage and high repair costs. This not only affects the community's physical resilience but also imposes additional economic strain on residents, who often have to borrow money to fund repairs (Indriani, Rahayu, & Hadiwidjojo, 2019). The findings underscore the necessity for more resilient construction practices and the implementation of flood-resistant building codes to reduce the community's vulnerability to future floods (Rehman et al., 2021).

The Role of the Institute for Supporting the Livelihoods of Farmers and Fishermen (LPUBTN) in Supporting Community Resilience

LPUBTN has played a pivotal role in enhancing the resilience of the Tambak Lorok community. The organization provides essential support, including building materials and training on flood-resistant construction techniques (Hansen et al., 2022). Moreover, LPUBTN has initiated programs aimed at economic diversification, helping to reduce the community's dependence on the vulnerable fishing sector.

Table 3. LPUBTN's Contributions to Community Resilience (June 2024)

Type of Support	Description
Material Assistance	Provision of building materials such as cement, bricks, and zinc roofing for home repairs.
Training Programs	Training in flood-resistant construction and business diversification to enhance economic resilience.
Community Engagement	Efforts to involve the community in resilience-building activities and promote sustainable practices.

The involvement of LPUBTN aligns with social resilience theory, which underscores the importance of local organizations in bolstering a community's adaptive capacity (Norris et al., 2018). LPUBTN's initiatives have been crucial in helping the community recover from floods and build more resilient homes. However, the research also reveals that the scope of LPUBTN's programs is limited by resource constraints, which hampers their ability to fully address the community's needs. To maximize the impact of LPUBTN's efforts, it is essential to expand these initiatives and ensure better integration with local government policies.

Evaluation of Mitigation Programs and Community Conditions

Mitigation programs, including levee construction and drainage improvements, have had varied success in Tambak Lorok. While these measures have alleviated some waterlogging issues, they are insufficient to fully protect the community from severe flooding, especially during heavy rains.

Table 4. Evaluation of Mitigation Programs in Tambak Lorok (June 2024)

Mitigation Measure	Effectiveness
Levee Construction	Reduced waterlogging in some areas but inadequate during heavy rainfall and high tides.

Drainage Improvements	Improved drainage capacity but still insufficient to prevent flooding in all areas.
Community Preparedness	Limited community awareness and preparedness for flood events, despite infrastructure improvements.

Disaster mitigation theory posits that effective disaster risk reduction requires a comprehensive approach, combining structural and non-structural measures (Cutter et al., 2018). The findings suggest that while the infrastructure improvements have provided some relief, they are not sufficient on their own. A more holistic strategy is needed—one that not only strengthens physical defenses but also enhances community preparedness and promotes adaptive practices. This could involve community-based disaster risk management initiatives, which have proven effective in building local resilience (Shaw & Izumi, 2019).

Conclusion

This study aimed to evaluate the resilience of the Tambak Lorok community to recurrent flooding, with a focus on socio-economic conditions, housing infrastructure, the role of LPUBTN, and the effectiveness of existing mitigation programs. The findings have demonstrated that while the community has developed some adaptive strategies, significant vulnerabilities remain, particularly in their economic dependence on fishing, the fragility of housing infrastructure, and the limited scope of mitigation efforts.

The research has shown that the socio-economic resilience of Tambak Lorok is critically weakened by the community's reliance on a single, flood-prone economic sector. This study advances the current understanding by highlighting the urgent need for economic diversification as a means to enhance resilience. Furthermore, the physical condition of housing in the area is inadequate to withstand the frequent flooding, underscoring the necessity for improved construction practices and the adoption of flood-resistant building codes.

LPUBTN has played a significant role in supporting the community's resilience, particularly through material assistance and training programs. However, the study identifies the need for expanded resources and better integration of these efforts with local government policies to maximize their impact. Additionally, the evaluation of current mitigation programs reveals that while some infrastructure improvements have been beneficial, they are insufficient on their own. A more holistic approach, integrating both structural improvements and community-based disaster management practices, is required to effectively reduce the community’s vulnerability to flooding.

In conclusion, this research contributes to the field by providing a detailed analysis of the challenges and opportunities for enhancing the resilience of coastal communities like Tambak Lorok. It highlights the critical areas where interventions are needed, particularly in economic diversification, infrastructure improvement, and the expansion of community-based resilience programs. These insights not only answer the research objectives but also offer practical recommendations for policymakers and practitioners aiming to improve flood resilience in similar contexts. The study underscores the

importance of a comprehensive and integrated approach to building resilience, which is crucial for the sustainability and safety of vulnerable coastal communities in the face of increasing environmental threats.

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