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LOCAL KNOWLEDGE FOR COASTAL RESILIENCE: ADAPTIVE STRATEGIES OF BAJO FISHERS IN POMALAA, INDONESIA

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ABSTRACT

This study examines the role of local knowledge in shaping adaptive strategies among the Bajo fishing community in Pomalaa, Southeast Sulawesi, Indonesia, in the face of rapid ecological changes driven primarily by coastal mining activities. Using a qualitative descriptive approach, based on three months of fieldwork (January–March 2023), data were collected through in-depth interviews, participant observation, and document analysis in several coastal villages directly impacted by environmental degradation. in-depth interviews with fishers and community leaders, participant observation of daily fishing and communal activities, and document analysis of relevant reports and policies. The findings reveal that traditional ecological knowledge manifested in fishing practices, environmental cues, and collective action remains central to the community's resilience and daily livelihood adaptation. However, the efficacy of local knowledge is increasingly challenged by accelerated environmental changes, modernization pressures, and the erosion of intergenerational knowledge transmission. While local adaptation strategies have fostered community resilience, persistent gaps exist due to limited policy support, rapid socio-ecological shifts, and weakened cultural continuity. This study underscores the need for integrating local and scientific knowledge in policy-making, empowering communities in environmental governance, and revitalizing cultural education to strengthen coastal resilience. The experience of the Bajo community offers valuable insights for sustainable coastal management and enriches the global discourse on the significance of local knowledge in socio-ecological adaptation.

KEYWORDS: Local Knowledge, Adaptation, Bajo, Coastal Resilience, Ecological Change, Pomalaa.

1. INTRODUCTION

Coastal communities around the world are increasingly vulnerable to ecological disruptions caused by both natural phenomena and human activities (Jozaei et al., 2022; Noor & Maulud, 2022). Among the various contributing factors, mining activities in coastal zones pose a significant threat to marine ecosystems and the livelihoods of traditional fishing communities (Silva et al., 2019; Tull et al., 2016). In Indonesia, coastal areas have long been recognized for their abundant natural resources and rich cultural diversity, but they are also among the regions most susceptible to environmental degradation and socio-economic marginalization (Drestalita et al., 2021; Waluyo et al., 2021).

The Bajo fishing community in Pomalaa, Kolaka, Southeast Sulawesi, represents a clear example of these challenges (Erfin et al., 2024; Taufik et al., 2023). Traditionally, the Bajo people are highly dependent on the sea for their livelihoods and, in the process, have developed sophisticated systems of local knowledge to guide their interactions with the marine environment (Mualim et al., 2024; Upe et al., 2022). This knowledge encompasses a deep understanding of fishing grounds, marine biota, navigation, and the use of environmentally friendly fishing techniques (Ali et al., 2019; Syarif, 2021). All of this is passed down from generation to generation and is deeply rooted in the community's cosmological beliefs and cultural identity (Arafah et al., 2022; Rasyid Asba & Ali, 2014; Rahman et al., 2019; Takwa et al., 2024).

In recent years, the Pomalaa coastal area has undergone significant ecological changes, primarily due to the expansion of nickel mining operations (Purnama et al., 2024; Purnama et al., 2025). These activities have led to widespread environmental degradation, damaging mangrove ecosystems, seagrass beds, coral reefs, and other marine life, and have seriously disrupted traditional fisheries and local livelihoods (Effendi et al., 2015; Imran et al., 2023). As a result, the Bajo community now faces a dilemma: on the one hand, they must utilize coastal resources to survive; on the other, ongoing environmental destruction threatens the very foundation of their existence (Irawati et al., 2018).

The dilemma faced by the Bajo community in Pomalaa reflects the challenges encountered by many coastal communities worldwide—namely, how to sustain their livelihoods and cultural identity amid the pressures of massive ecological change. In such conditions, local knowledge serves not only as a cultural heritage but also as adaptive capital in confronting environmental uncertainties. Recent studies affirm that local knowledge holds great potential for enhancing coastal resilience and supporting sustainable adaptation strategies. However, more in-depth research is needed on how such knowledge is mobilized and integrated to address rapid environmental changes, particularly in coastal areas directly affected by mining. Therefore, a more comprehensive understanding of the role of local knowledge in the adaptation processes of coastal communities is essential, both for the advancement of scientific knowledge and the formulation of sustainable environmental management policies.

This adaptation dilemma is also experienced by many other coastal communities around the globe, making it important to review how global literature addresses the relationship between local knowledge, community adaptation, and environmental change. Previous studies have documented the impact of ecological change on coastal fisheries and the vulnerability of fishing communities (Helmi & Satria, 2012; Hamzah, 2016; Badjeck et al., 2010). Other studies have highlighted the importance of local knowledge systems and traditional wisdom in the management of marine resources (Hafid, 2014; Permana, 2020). However, few have examined how local knowledge is actively mobilized as an adaptive strategy in response to rapid environmental disruption caused by mining, particularly in Indonesia's highly diverse coastal regions.

However, these studies tend to focus on documenting practices or describing cultural heritage, rather than analyzing how local knowledge is actively mobilized and transformed as an adaptive strategy under conditions of rapid, mining-driven ecological disruption. This represents a significant research gap, particularly in the Indonesian context where mining expansion and socio-ecological diversity intersect.

This study aims to fill this gap by examining the role of local knowledge in shaping adaptive strategies for coastal resilience among the Bajo fishing community in Pomalaa. By focusing on the interaction between traditional ecological knowledge and contemporary environmental challenges, this research highlights the significance of local wisdom not only as cultural heritage but also as the foundation for sustainable adaptation and resilience. The findings are expected to provide practical insights for policymakers and contribute to broader discourses on integrating local knowledge into coastal governance and environmental policy, both in Indonesia and in similar contexts globally.

2. LITERATURE REVIEW

2.1. Coastal Ecological Change And Community Vulnerability

Coastal communities in various parts of the world are becoming increasingly vulnerable to ecological changes driven by both natural factors and human activities, including intensive resource exploitation and industrial development (Folke et al., 2005; Adger, 2000). Specifically, mining activities in coastal areas have been shown to significantly damage marine ecosystems, threaten traditional livelihoods, and heighten the vulnerability of marginalized groups such as small-scale fishers (Noble et al., 2016; Ovadia et al., 2022). In Indonesia, the rapid expansion of mining in coastal regions has resulted in widespread environmental degradation, evidenced by the destruction of mangrove forests, coral reefs, and seagrass beds, as well as disruptions to the socio-economic fabric of fishing communities (Hamzah, 2016).

2.2. The Impact Of Mining On Coastal Communities

Various studies conducted in Southeast Sulawesi and other mining-affected regions highlight the complex ecological and social challenges faced by coastal communities. Helmi and Satria (2012) identified that ecological changes resulting from mining can drastically reduce fish availability, lower fishers' incomes, and increase the costs of accessing marine resources. These changes are often exacerbated by socio-political dynamics, where conflicting regulatory and policy frameworks may worsen ecosystem degradation. Hamzah's (2016) research in Pomalaa underscores the specific vulnerabilities associated with open-pit nickel mining, particularly in terms of increased sedimentation, water pollution, and disturbances to aquatic biota.

2.3. Local Knowledge And Adaptive Strategies

Local knowledge and traditional wisdom have been widely recognized as essential resources for community adaptation and coastal resilience (Berkes et al., 2000; Nursey-Bray et al., 2019). This knowledge encompasses not only ecological understanding, but also traditional practices, belief systems, and social norms that shape sustainable resource management (Hafid, 2014; Permana, 2020). For example, studies on the Tolaki Mekongga community in Kolaka demonstrate how cultural values embedded in the Mowindahako ritual serve to strengthen social cohesion and reinforce sustainable relationships with the environment (Takwa et al., 2025). Numerous studies have documented the importance of local knowledge in guiding adaptive responses to environmental changes in coastal areas (Badjeck et al., 2010; Arianti et al., 2023). However, most existing research remains descriptive, mainly focusing on documenting local practices rather than examining how such knowledge is mobilized and transformed in response to rapid ecological disruption caused by mining.

2.4. Research Gaps

Although previous studies have highlighted the vulnerability of coastal communities to ecological change and the importance of local knowledge in resource management, there is still very little comprehensive analysis of how local knowledge systems are operationalized as adaptive strategies—especially in regions impacted by mining. Few studies have explored the dynamic processes of integrating local knowledge into adaptation and resilience strategies, as well as their potential contributions to policy and environmental management practices. This study seeks to address these gaps by examining the mobilization of local knowledge as an adaptive strategy for coastal resilience among the Bajo fishing community in Pomalaa, with an emphasis on their lived experiences in facing environmental changes due to mining.

3. METHODOLOGY

3.1. Research Design

This study employs a descriptive qualitative approach to examine the impacts of ecological change and the role of local knowledge within the Bajo fishing community in Pomalaa, Southeast Sulawesi. The qualitative approach was chosen to capture the depth and complexity of community perceptions, adaptation strategies, and the dynamic interaction between tradition and environmental change.

3.2. Research Location And Participant Selection

The research was conducted in three coastal villages: Hakatutobu, Tambea, and Sopura, all located in Pomalaa District, Kolaka Regency, Southeast Sulawesi. These villages were purposively selected as the majority of their residents are Bajo fishers who are directly affected by ecological changes resulting from mining activities. Research participants consisted of experienced fishers, community leaders, and local public figures, selected

through purposive and snowball sampling techniques to obtain a diverse range of perspectives and in-depth knowledge.

3.3. Data Collection Techniques

Data collection was carried out from January to March 2023 using several primary techniques. First, in-depth interviews were conducted with traditional elders, fishers, and local community leaders, using a semi-structured interview guide. This technique aimed to thoroughly explore perceptions, experiences, and local knowledge related to ecological changes and the adaptation strategies developed by the Bajo community. In addition, participant observation was conducted during various daily fishing activities, community meetings, and local environmental management practices to gain a more contextual and authentic understanding of the socio-ecological dynamics in the field. Data collection was further supported by document analysis of various secondary sources, including books, journal articles, dissertations, statistical reports from the Central Statistics Agency (BPS), news releases, government documents, and environmental regulations relevant to the research topic. The combination of these techniques was intended to provide a comprehensive and in-depth portrayal of the phenomena under study.

3.4. Data Analysis

Data analysis in this study was conducted continuously from the initial stages of data collection to the conclusion of the research process, to ensure coherence between field findings and the researcher's interpretation. The analysis process began with data reduction, where raw data from interviews, observations, and documents were selected and sorted based on their relevance to the research focus. Manual coding was then performed to identify central themes that emerged from the data.

Subsequently, data categorization was carried out by grouping the coded results into several main categories, such as patterns of ecological change, community adaptation strategies, and forms of local knowledge mobilization. Each category was analysed in depth to reveal inter-theme relationships and internal dynamics within the Bajo community. In the interpretation stage, the researcher constructed a holistic understanding of how local knowledge is integrated into adaptive responses to environmental changes induced by mining activities.

To ensure the validity and reliability of the findings, this study applied data source triangulation by comparing information obtained from interviews, participant observation, and secondary documents. In addition, cross-checks with several key informants (member checking) were performed to confirm the accuracy and validity of the data and research interpretations. Through this systematic and layered data analysis process, the study aims to generate a comprehensive and in-depth understanding of the Bajo fishing community's local knowledge-based adaptation strategies in facing coastal ecological changes.

Table 1: Summary of Research Data Collection Procedures.

Data Source	Collection Technique	Informant/Participant	Location / Time	Data Type	Description
Interview	In-depth, semi-structured	Udding Marannuang (Community leader), Anwar (Fisher)	Hakatutobu Village, March 2023	Primary Data	Exploration of local knowledge, perceptions of ecological change, and adaptation strategies
Observation	Participant observation	Bajo fishers in Hakatutobu, Tambea, Sopura	January – March 2023	Primary Data	Observation of fishing activities, community meetings, and local environmental management practices
Document	Document analysis	Statistical data (BPS Southeast Sulawesi, BPS Kolaka); Journals (Helmi & Satria, Hamzah); Dissertations, books, news, regulations	Kolaka, 2015–2023	Secondary Data	Secondary data from publications, official reports, internet sources, and environmental legal documents

4. RESULT

4.1. Ecological Change And Its Impact On The Lives Of Bajo Fishers In Pomalaa

The findings of this study indicate that the coastal area of Pomalaa has experienced highly significant ecological changes over the past two decades, mainly due to the expansion of large-scale nickel mining activities. These changes are reflected in the degradation of key ecosystems such as mangroves, seagrass beds, and coral reefs. Field observations in Hakatutobu, Tambea, and Sopura Villages revealed that seawater around these coastal areas often turns reddish-brown, especially after heavy rainfall, as a result of sedimentation and mining waste runoff.

Interviews with several fishers and community leaders indicated that the destruction of mangrove ecosystems has reduced nursery grounds for fish, shrimp, and crabs. This has had a direct impact on the decline in catches, particularly fish and shrimp, which are the primary commodities for Bajo fishers. Additionally, the mass mortality of seaweed and sea cucumbers, which previously served as alternative sources of livelihood, has occurred more frequently in recent years.

According to Udding Marannuang, a community leader from Hakatutobu, before these environmental changes occurred, fishing activities could be carried out close to the shore with relatively abundant catches. However, at present, fishers are forced to venture further out to sea to obtain sufficient catches, leading to increased time and operational costs. Some fisher families have been compelled to switch professions to become day labourers or leave the village in search of other livelihoods. An interview with Anwar, a local fisher, also confirmed that most Bajo fishers still choose to go to sea even though their incomes are declining, as cultural attachment and identity as fishers remain very strong in their community.

The ecological changes have not only impacted the economic aspect but have also triggered social tensions at the local level. The Bajo community in several affected villages frequently submits protests to mining companies and local government authorities, demanding compensation or concrete solutions for the environmental damage that has occurred. In addition to formal channels, advocacy is also conducted in collaboration with environmental NGOs and legal aid institutions.

The findings of this study demonstrate that ecological changes resulting from mining activities in Pomalaa have had a systemic impact on the economic, social, and cultural lives of the Bajo fishing community. Community resilience is being tested through daily adaptation and survival strategies that continue to develop amid increasingly severe environmental pressures.

Various human activities, especially those related to mining and coastal infrastructure development, have caused several significant ecological changes in the Pomalaa area. The impact of these activities is felt not only on ecological aspects, but also triggers social and economic implications for the Bajo fishing community. A summary of the relationship between human activities, the resulting ecological changes, and their impacts on society is presented in Table 2 below.

Table 2: The Relationship Between Human Activities, Ecological Change, And Their Impacts In The Pomalaa Coastal Area.

Human Activities	Ecological Change	Social, Economic, and Ecological Impacts
Dredging & stockpiling of materials	Increased seawater turbidity	Sedimentation, disrupted hydrological cycles, erosion, disturbed aquatic biota
Construction of ports/jetty	Mangrove destruction & coastal runoff	Loss of nursery areas for marine biota, coastal shallowing, shoreline erosion, disrupted biota regeneration, damaged seagrass beds
Excavation & removal of topsoil	Mangrove ecosystem damage, erosion	Water pollution, seaweed/sea cucumber mortality, turbid seawater, watershed pollution
Ship anchoring	Coral reef damage	Physical damage to coral reefs, loss of fishing grounds, changes in fish migration patterns

As shown in Table 2, dredging and stockpiling activities have caused an increase in seawater turbidity, which disrupts the hydrological cycle and reduces fishers' catches. Similar impacts are observed in the construction of jetties, which accelerate the destruction of mangrove ecosystems and cause the loss of nursery grounds for marine biota.

4.2. Adaptation Strategies And Local Knowledge Of The Bajo Fishing Community

Amid ongoing ecological pressures caused by nickel mining activities, the Bajo fishing community in Pomalaa has developed various adaptation strategies rooted in local knowledge and age-old traditions. Observations and interviews revealed that this local knowledge goes beyond fishing techniques; it encompasses a deep understanding of seasonal

patterns, ocean currents, natural signs, and innovations in environmentally friendly fishing gear.

Some forms of knowledge and adaptive practices that are still maintained include the use of traditional fishing gear, such as bubu (fish traps), simple trawl nets, and the nyulu technique (catching fish with petromax lamps at night in shallow waters). Fishers also practice ngampe, which involves setting nets at specific locations during high tide, as well as belle, building bamboo fences on the shoreline to trap fish during low tide. In addition, techniques for gathering seafood, such as shellfish and sea cucumbers, at low tide (noob) are still widely practiced, along with the use of FADs (rumpon) to attract pelagic fish, like tuna, to fishing grounds.

Local knowledge is also evident in the fishers' ability to read natural signs, such as changes in water color, wind direction, and the appearance of particular marine species that indicate fishing seasons. In the face of extreme environmental changes, such as declining water quality due to sedimentation and mining waste, there is a need for action. Bajo fishers attempt to adapt by expanding their fishing grounds to deeper waters or switching to other available marine species.

This knowledge is typically passed down orally through intergenerational interaction within the community. Children and youth are involved directly in fishing activities from an early age, learning the techniques, locations, and timing for fishing, as well as internalizing the Bajo philosophy of life that is deeply connected to the sea (Takwa et al., 2022; Takwa et al., 2024). Collective values and community solidarity also serve as social capital in facing the challenges of ecological and economic change.

Nevertheless, some fishers feel that their local knowledge is increasingly threatened by environmental changes that can no longer be fully predicted or managed with traditional wisdom. The introduction of new technology and modernization also presents unique challenges to the preservation of local knowledge, especially among younger generations who are beginning to abandon the fishing profession.

These local knowledge-based adaptation strategies have become a crucial foundation for the resilience of the Bajo community in Pomalaa. However, their effectiveness is now being increasingly tested by the complex and intensifying dynamics of environmental change.

Table 3: Types of Local Knowledge and Traditional Fishing Practices of the Bajo Fishing Community in Pomalaa.

No	Local Knowledge Form	Activity Description	Area/Zone	Equipment	Catch/Output
1	Ngampe	Fishing with nets (trawl) during high tide at specific locations over sappa (taka); catch collected at low tide. Generally in shallow waters or near mangroves.	Shallow sea & coast	Nylon net	Fish, crabs, shrimp, other marine biota
2	Belle	Constructing bamboo/wooden fences at the shoreline, like fish cages with a special door. At low tide, fish/marine biota are trapped and collected.	Coast	Wood/bamboo & fish cage nets	Fish, other marine biota
3	Nyulu	Night fishing for marine biota on the coast using petromax lamps, either by canoe or on foot.	Coast	Petromax lamp, machete, spear, arrow	Fish, shellfish, shrimp, crab, cucumber
4	Floating	Night fishing in deep sea using petromax lamp as illumination on the boat.	Deep sea	Fishing line, hooks, other fishing tools	Fish, squid
5	Rumpon (FAD)	Fishing around fish aggregating devices (FADs) in the deep sea, typically made from	Deep sea	Fishing line, hooks	Tuna, mackerel, other pelagic fish

		bamboo, anchored to float in place.			
6	Bubu	Setting up traditional, eco-friendly fish traps in shallow or deep sea.	Shallow & deep sea	Fish trap (bubu)	Fish, sea cucumber, other marine biota
7	Noob	Gathering seafood at low tide, usually shellfish, but also other marine products.	Coast	Machete, spear, basket/bucket	Shellfish, sea cucumber, fish
8	'I want to'	Fishing with multiple hooks (7–10) baited and weighted, lowered vertically. Targeting reef fish.	Shallow & deep sea	Hooks, line	Grouper, snapper, rockfish
9	The Friend (Octopus)	Catching octopus with simple fishing gear; innovation with gear resembling octopus or crab, also iron spears.	Shallow sea	Hook, spoon, iron, spear	Octopus
10	Massodo/Nyodo	Collecting milkfish fry along the coast using dried banana leaves joined as a net.	Coast	Dried banana leaf, rope, scoop net	Milkfish fry (nener)
11	Screaming/Marlo	Fishing with silk thread, marlo, or gold thread; traditional, eco-friendly gear.	Shallow sea	Thread, hooks, wire, line	Sunu, snapper, white fish, barracuda
12	Kende's Mission	Squid fishing with bright-colored shrimp-like lures, equipped with a small flashing light (bahlon) to attract squid in shallow/deep water.	Shallow & deep sea	Line, artificial shrimp lure, hook, bahlon light, sinker	Squid, fish

Source: Summary of Interview Results with Fishermen of Hakatutobu Village, Pomalaa District, March 4, 2023.

Table 3 illustrates the richness of the Bajo community's fishing strategies and locally-based adaptation practices. Techniques such as ngampe, nyulu, and bubu remain mainstays, while innovations in fishing tools and location selection methods demonstrate the community's ability to adapt to continuously changing environmental conditions. The transmission of this knowledge occurs orally across generations, ensuring that traditional values and solidarity are maintained despite the growing challenges of modernization.

4.3. Community Responses And Collective Efforts In Facing Ecological Change

The increasingly apparent ecological changes along the Pomalaa coast have not only impacted economic and ecological aspects but have also triggered various social responses and collective efforts from the Bajo fishing community. Findings indicate that the Bajo community does not remain passive in the face of environmental degradation; instead, they actively engage in actions to defend their rights and demand environmental justice.

One of the primary forms of community response is advocacy and protest directed at mining companies and local government authorities regarding environmental damage and the declining quality of life for fishers. Affected residents, through community forums, often demand that mining companies be held accountable for ecosystem destruction, including requests for compensation, rehabilitation programs, and support for fisher families who have lost their primary sources of income. In some cases, community protests are accompanied by environmental NGOs, legal aid organizations, and advocacy groups to strengthen the bargaining position of the community before companies and the government.

One local fisherman, Anwar, expressed:

"We do not remain silent. We have reported to the government several times, urging companies to pay more attention to environmental conditions. Sometimes, assistance does come, but often we have to fight on our own, relying on cooperation to survive."

4.3.1. (Interview, March 2023)

In addition to formal advocacy, the Bajo community also undertakes internal adaptation in

the form of gotong-royong (mutual assistance) and strengthening of communal solidarity. For instance, in times of failed fish harvests or mass mortality of cultivated species such as sea cucumbers, fishing families help each other to meet basic needs and share whatever catch remains. This collective practice is a deeply rooted social value within the Bajo culture and serves as a survival strategy during crises (Arafah et al., 2022; Takwa et al., 2024).

The community has also initiated independent environmental rehabilitation efforts, such as mangrove planting along the coast and the maintenance of traditional fishing areas to ensure their continued productivity. However, these efforts frequently encounter challenges due to limited resources and minimal external support. Several community members have expressed their concerns:

"We once planted mangroves together, but it is difficult without seedling support and guidance from outside the village. Still, our spirit to restore the environment never fades."

(Udding Marannuang, interview, March 2023)

Ecological changes have also led to shifts in family roles. Some women have begun engaging in alternative economic activities such as seafood processing, small-scale trading, or informal employment outside the village. Meanwhile, some young people have chosen to migrate to cities in search of work, leaving behind the fishing tradition passed down from their parents.

These findings indicate that the Bajo community's response to ecological change is not limited to individual adaptation but also encompasses collective action, advocacy, and social innovation that are vital for maintaining community sustainability amid severe environmental pressures. All of these efforts demonstrate that social resilience and collective innovation serve as the main assets of the Bajo community in responding to change, even though structural challenges and limited resources remain significant obstacles.

5. DISCUSSION

5.1. The Effectiveness Of Local Knowledge In Adaptation

The findings of this study demonstrate that the local knowledge possessed by the Bajo fishing community in Pomalaa plays a pivotal role in adaptation efforts in response to coastal ecological changes. Various tradition-based adaptation strategies, such as the use of environmentally friendly fishing gear, the selection of fishing locations based on natural indicators, and the practice of cooperation (gotong royong) during times of crisis, prove that local knowledge is not merely a cultural heritage, but also a tangible adaptive asset.

The success of the Bajo community in maintaining their livelihoods amid severe environmental pressures aligns with global findings regarding the role of Local Ecological Knowledge (LEK) in enhancing the resilience of coastal communities. Berkes et al. (2000) assert that LEK can strengthen a community's ability to respond to environmental changes in more contextual and sustainable ways. Nursey-Bray et al. (2019) also emphasize the importance of recognizing local knowledge in decision-making and coastal resource management processes, especially in regions vulnerable to climate change and resource exploitation.

In Pomalaa, adaptation strategies such as ngampe, nyulu, and bubu are still maintained because they are considered most suitable for the local environmental conditions and the unpredictable seasonal changes resulting from mining activities. Local wisdom in reading natural signs such as changes in water color, current patterns, and the presence of indicator species helps fishers optimize their catch while minimizing environmental damage. In addition, the values of solidarity and collectivity within the community serve as important strengths in facing crises, such as fishery failures or mass mortality in aquaculture.

Nevertheless, the effectiveness of local knowledge as an adaptation strategy is increasingly challenged by the rapid pace of environmental change, which often cannot be anticipated by traditional wisdom alone. This phenomenon is also observed by Fazey et al. (2006), who note that LEK tends to be most effective under relatively stable environmental conditions, but requires the support of innovation and the integration of scientific knowledge when faced with significant exogenous changes, such as mining expansion or industrial pollution.

Thus, the results of this study reaffirm the importance of recognizing and integrating local knowledge into coastal adaptation strategies. Local knowledge has been proven effective in building community resilience. However, it must be supported by interdisciplinary collaboration, technological innovation, and policies that prioritize resource conservation and the empowerment of local communities.

5.2. Gaps, Threats, And Opportunities

Although local knowledge has proven to be an essential asset in the adaptation strategies of the Bajo fishing community, this study also reveals several gaps and threats that could undermine the long-term

effectiveness of local knowledge. One of the most significant challenges is the incredibly rapid pace of environmental change, often beyond the adaptive capacity of traditional knowledge, especially as a result of industrial mining expansion and coastal pollution. Such changes have rendered some traditional knowledge and practices less effective in responding to the new dynamics of the environment.

In addition, there is the threat of modernization and the influx of new technologies into coastal villages. On one hand, innovation and technological access can offer opportunities to strengthen adaptation, for example, through improved weather monitoring or better management of fishery resources. However, modernization also contributes to the erosion of local knowledge, particularly among the younger generation, who are increasingly less interested in pursuing the fishing profession. This finding echoes Tetelepta al. (2023), who argue that local knowledge is often not effectively transmitted to the next generation due to shifting economic, educational, and social value orientations.

Dependence on modern fishing gear, changes in consumption patterns, and urbanization also contribute to the loss of traditional practices and customs that have long served as the foundation of community-based adaptation. The process of knowledge transmission, which once occurred organically through daily interaction, is now increasingly interrupted. Meanwhile, weak policy support and limited access to community empowerment programs remain structural barriers commonly faced by fishing communities.

Despite these challenges, there remain significant opportunities to revitalize and strengthen the role of local knowledge in the adaptation of coastal communities. The integration of local and scientific knowledge (co-production of knowledge) can serve as a new strategy to enhance adaptive capacity, as suggested by Tengö et al. (2014). Moreover, the active involvement of communities in environmental policy-making, the strengthening of culturally-based education, and collaboration with NGOs and research institutions can all support the sustainability of adaptive local practices.

Therefore, efforts to preserve and revitalize local knowledge must be carried out in an integrated manner through education, policy support, and technological innovation that does not marginalize community wisdom and cultural identity. The experience of the Bajo community in Pomalaa can offer valuable lessons for sustainable coastal management in other regions facing similar environmental pressures.

5.3. Policy And Research Implications

The findings of this study underscore the critical importance of recognizing and integrating local knowledge into the formulation of coastal management policies and community adaptation strategies in response to ecological change. Policies that are sensitive to socio-cultural contexts and based on community participation have proven to be more effective in fostering community resilience compared to top-down approaches.

First, both local and national governments need to provide greater opportunities for local communities to actively participate in the planning and implementation of environmental rehabilitation programs and coastal resource management. Such involvement not only strengthens the legitimacy of policies but also ensures that solutions adopted are relevant to the needs and realities of communities on the ground. This can be operationalized through participatory forums (musyawarah pesisir), inclusion of fisher representatives in coastal planning boards, and legally mandated community consultations prior to industrial projects. Such mechanisms not only strengthen policy legitimacy but also ensure solutions that are contextually relevant.

Second, the integration of local and scientific knowledge should be promoted through mechanisms of dialogue between stakeholders (co-production of knowledge). Training programs, field schools, and communication forums involving fishers, academics, and government officials can serve as platforms for knowledge exchange, technological innovation, and joint learning to address rapidly changing environmental dynamics. the integration of local and scientific knowledge should be promoted through structured co-production mechanisms. This can include establishing coastal learning hubs or community field schools where fishers, researchers, and policymakers meet regularly to exchange practices; using participatory mapping tools for marine spatial planning; and involving local fishers in citizen science initiatives (e.g., monitoring water quality or fish stocks).

Third, the preservation of local knowledge can be reinforced through the development of culturally based educational curricula and by encouraging youth participation in both traditional and innovative fisheries practices. Educational programs, documentation of traditions, and incentives for fisher regeneration are crucial for ensuring the continuity of knowledge and community resilience in the future. the preservation of local knowledge can be

reinforced through the integration of culturally based content into school curricula at village or district levels, and through programs that incentivize youth engagement in traditional and innovative fisheries. For example, vocational training that combines modern aquaculture with Bajo fishing traditions, or scholarships for students who conduct research on local ecological knowledge, could ensure continuity across generations.

Fourth, it is essential to strengthen policies that firmly protect the rights of coastal communities and guarantee compensation or empowerment programs for those affected by industrial activities, particularly in mining areas. The state must also ensure legal protection and access to legal aid or environmental advocacy. policies must explicitly protect the rights of coastal communities and guarantee compensation or empowerment programs for those affected by industrial activities, particularly mining. This can take the form of community-managed funds sourced from corporate social responsibility (CSR) obligations, mandatory rehabilitation projects tied to mining licenses, and accessible legal aid services for affected communities.

From a research perspective, there remains considerable scope for further studies on the most effective models of integrating local and scientific knowledge across diverse coastal ecosystems in Indonesia. Collaborative, cross-disciplinary, and multi-regional research can generate innovative adaptation strategies and enrich the global literature on community resilience based on local knowledge.

It is hoped that the findings of this study can serve as a foundation for formulating inclusive and sustainable coastal management policies, as well as inspire the strengthening of adaptive capacities among coastal communities in other regions facing similar challenges.

From a research perspective, future studies should develop pilot models of LEK–scientific integration and test their effectiveness across diverse ecosystems (mangrove, coral reef, seagrass). Collaborative, cross-disciplinary, and multi-regional research, ideally involving both local universities and community groups, can generate context-specific adaptation strategies while enriching the global discourse on socio-ecological resilience.

Ultimately, these recommendations emphasize that inclusive policy frameworks, educational reforms, and institutionalized platforms for dialogue are essential for transforming local knowledge from cultural heritage into a practical foundation for sustainable adaptation.

6. CONCLUSSION

This study reveals that the local knowledge possessed by the Bajo fishing community in Pomalaa plays a crucial role as the foundation for adaptive strategies in facing coastal ecological changes resulting from industrial mining expansion and other environmental pressures. Various traditional practices and innovations rooted in local wisdom have proven effective in strengthening community resilience in responding to the economic, social, and ecological challenges they encounter. Nevertheless, the effectiveness of local knowledge is increasingly being tested by the rapid pace of environmental change, the wave of modernization, and the weakening of traditional knowledge transmission to younger generations.

The main challenges lie in the gap between traditional adaptive capacities and the dynamics of the new environment, as well as limited policy support and access to resources. On the other hand, opportunities to enhance community resilience remain open through the integration of local and scientific knowledge, the strengthening of community participation in coastal management, and the development of education and policies that prioritize cultural preservation.

The findings of this research underscore the importance of recognizing, preserving, and revitalizing local knowledge as an integral part of sustainable coastal management strategies. The recommendations proposed include: empowering communities through active participation in policy formulation, developing education programs based on local culture, and fostering cross-sector collaboration to encourage adaptive innovation in coastal regions.

Beyond the local context, this study contributes to broader debates on climate change adaptation by showing how traditional ecological knowledge can complement scientific approaches to build resilience in vulnerable coastal communities. It also highlights the relevance of local knowledge in environmental governance, emphasizing the need for inclusive, bottom-up policy frameworks that respect cultural identity while addressing ecological pressures.

The experience of the Bajo community in Pomalaa can serve as a valuable lesson for policy development and research in other coastal areas facing similar environmental pressures, as well as enrich the global discourse on the role of local knowledge in building socio-ecological resilience.

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