



Integration of Socio-Ecological Systems in Community-Based Sustainable Coastal Management

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ABSTRACT

This study aims to analyze the integration of socio-ecological systems in community-based sustainable coastal management in Teluk Awur Village, Jepara Regency, Central Java, Indonesia. The study addresses the problem of coastal degradation, livelihood vulnerability, unequal participation, and weak institutional coordination in local coastal governance. A qualitative case study approach was used to explore community experiences, local ecological knowledge, participation patterns, actor relations, and adaptive practices. Data were collected through semi-structured interviews, limited participant observation, documentation, and methodological triangulation involving fishermen, mangrove group members, coastal tourism managers, village officials, local leaders, women involved in coastal economic activities, youth representatives, and local environmental agency officers. The findings reveal four main themes: local ecological knowledge as a basis for coastal action, community participation as shared responsibility, livelihood pressure as a constraint on sustainability, and institutional coordination as a condition for socio-ecological integration. The study shows that coastal communities understand environmental change through daily experience, livelihood disruption, spatial memory, and collective practice. However, participation remains uneven when communities are involved in program implementation but have limited influence in planning and decision-making. This study contributes to socio-ecological systems theory by showing that coastal resilience emerges from the interaction between ecological recovery, social learning, institutional trust, and livelihood adaptation. The findings suggest that coastal policy should strengthen participatory planning, livelihood-sensitive conservation, and long-term community-based governance.



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1. Introduction

Coastal areas face growing pressure from climate change, ecosystem degradation, land-use change, tourism expansion, and increasing dependence on marine resources. These pressures show that coastal management is not only an environmental issue, but also a social, cultural, economic, and institutional issue. Coastal communities depend on fisheries, mangroves, aquaculture, and coastal tourism for their livelihoods. At the same time, they also experience the direct effects of coastal erosion, declining fish stocks, mangrove loss, and conflicts over resource

use. The socio-ecological systems perspective offers a relevant framework because it views coastal ecosystems and human communities as connected systems that shape each other through everyday practices, local knowledge, institutions, and adaptation. Refulio-Coronado et al. (2021) explain that coastal and marine socio-ecological systems research has increasingly focused on resilience, vulnerability, adaptive capacity, and governance. This perspective helps explain why sustainable coastal management needs to integrate ecological protection with community welfare and local decision-making.

In Indonesia, coastal management has become a strategic issue because many coastal villages rely directly on natural resources for food security, income, and social identity. Community-based coastal management has been promoted through mangrove rehabilitation, small-scale fisheries management, coastal tourism, and local conservation programs. However, its implementation often faces unequal participation, limited institutional support, weak coordination, and short-term economic pressure. Damastuti et al. (2022) found that community-based mangrove management in Central Java can support biodiversity conservation when local participation and long-term maintenance are sustained. In a later study, Damastuti et al. (2023) showed that the effectiveness of community-based mangrove management differs across local contexts because each community has different ecological conditions, social capacity, and institutional support. These findings indicate that coastal management cannot rely only on technical conservation programs. It needs to understand how local communities experience, interpret, and negotiate ecological change.

Field realities show that local communities often participate in coastal programs, but their role remains limited in planning and decision-making. Many programs involve residents in mangrove planting, coastal cleaning, ecotourism services, and environmental campaigns. However, participation is sometimes treated as labor contribution rather than meaningful involvement in governance. Baker and Constant (2020) argue that local ecological knowledge can strengthen marine conservation, but its integration is often constrained by unequal power relations and limited trust between communities and formal institutions. McKinley et al. (2021) also emphasize that coastal community engagement must be built through communication that fits local realities, access, and knowledge systems. Therefore, participation in sustainable coastal management needs to be understood as a social process that includes recognition, negotiation, trust, and shared responsibility.

This issue is important because coastal degradation affects ecological stability, livelihood security, cultural continuity, and community resilience. Coastal communities do not only respond to environmental change through formal programs. They also adapt through livelihood diversification, informal cooperation, local rules, and inherited ecological knowledge. Lazzari et al. (2021) show that coastal vulnerability is shaped by the interaction between ecological pressure, fishing activities, tourism development, and socio-economic exposure. Jozaei et al. (2022) further explain that coastal governance needs to connect social vulnerability with social-ecological resilience to produce more adaptive management. In this context, sustainable coastal management requires a deeper understanding of how communities build resilience through everyday practices, local institutions, and collective responses to environmental uncertainty.

Previous studies have examined socio-ecological systems, mangrove conservation, coastal resilience, co-management, and community participation. However, many studies still focus on program effectiveness, ecological indicators, economic benefits, or governance models. Fewer studies explore the meaning, experience, and social process behind community-based coastal management. Elrick-Barr et al. (2024) note that coastal governance innovation often remains incremental and has not always produced transformative social-ecological resilience. Macamo et al. (2024) also show that community-based mangrove management depends on local leadership, incentives, compliance, and community relations. This gap shows the need for qualitative research that can examine how local communities integrate ecological knowledge, social relations, institutional support, and livelihood needs in coastal management.

Based on this gap, this study aims to analyze the integration of socio-ecological systems in community-based sustainable coastal management. The study focuses on local experiences, ecological knowledge, forms of participation, actor relations, adaptive practices, and institutional dynamics in coastal governance. Theoretically, this study contributes to the development of socio-ecological systems theory by explaining how social, ecological, cultural, and institutional dimensions interact in a specific coastal community. Practically, this study provides insights for local governments, coastal managers, community organizations, and environmental facilitators in designing coastal governance that is participatory, adaptive, and sensitive to local contexts. Quimby et al. (2023) show that co-management can strengthen social-ecological resilience when community needs and resource governance are connected. Oliveira et al. (2022) also highlight the importance of understanding dynamic relationships between climate, coastal space, and community life.

2. Materials and Methods

This study uses a qualitative case study approach. This approach was selected because the research aims to understand the process, meaning, experience, and interaction among local actors in community-based coastal management. A case study is suitable for examining a contemporary phenomenon within a real-life context, especially when social, ecological, institutional, and cultural dimensions are closely connected. Chowdhury and Shil (2021) explain that qualitative case study research allows researchers to build a holistic understanding of complex social events. Miller et al. (2023) also state that case study design helps researchers develop systematic and transparent procedures for investigating context-bound phenomena. Therefore, this study treats community-based coastal management as a case that reflects the interaction between local livelihood, coastal ecosystems, community participation, and institutional governance.

The research will be conducted in Teluk Awur Village, Jepara Regency, Central Java, Indonesia, from June to September 2026. This location was selected because it has coastal community activities, mangrove-related initiatives, small-scale fisheries, coastal tourism, and local environmental management practices. The research participants will include fishermen, mangrove group members, coastal tourism managers, village officials, local community leaders, youth representatives, women involved in coastal economic activities, and officers from local environmental or marine agencies. Informants will be selected using purposive sampling based on direct involvement in coastal management, knowledge of local ecological change, and experience in community-based activities. Snowball sampling will also be used to identify additional informants who understand historical changes, community conflicts, informal leadership, or institutional cooperation. Celliers et al. (2023) explain that stakeholder mapping is important in coastal socio-ecological governance because different actors have different levels of power, interest, and responsibility.

Data will be collected through semi-structured interviews, limited participant observation, documentation, and methodological triangulation. Semi-structured interviews will explore community experiences related to coastal ecosystem change, mangrove management, livelihood adaptation, participation, local knowledge, institutional support, and conflicts over coastal resource use. Observation will be conducted during community activities, such as mangrove maintenance, fishing routines, coastal tourism practices, village meetings, environmental campaigns, and informal discussions among residents. Documentation will include village regulations, program reports, activity archives, coastal maps, photographs, meeting notes, and policy documents related to coastal management. Baker and Constant (2020) highlight the importance of local ecological knowledge in marine conservation planning, especially when communities have long-term experience with environmental change. McKinley et al. (2021) also show that coastal engagement becomes more meaningful when data collection practices are sensitive to local communication patterns and community realities.

Data validity will be strengthened through source triangulation, method triangulation, member checking, and audit trail. Source triangulation will compare information from community members, village officials, local leaders, government officers, and documents. Method triangulation will compare interview findings, observation notes, and documentary evidence. Member checking will be conducted by returning key summaries, preliminary themes, and selected interpretations to several key informants to confirm whether the researcher's understanding reflects their experiences. McKim (2023) argues that member checking should be structured so it can strengthen the credibility of interpretation, not only verify transcripts. Audit trail will be maintained through field notes, reflective memos, interview logs, coding records, and documentation of analytical decisions. Ahmed (2024) states that credibility, transferability, dependability, and confirmability are important pillars of trustworthiness in qualitative research.

Data analysis will use thematic analysis supported by the interactive model of qualitative data analysis. The analysis will begin with transcription, repeated reading, memo writing, and initial coding. Open coding will identify meaning units related to local ecological knowledge, community participation, livelihood adaptation, institutional relations, coastal conflict, environmental awareness, and conservation practices. These codes will then be grouped into broader themes, such as integration of local knowledge and formal policy, community roles in conservation, socio-economic pressure on ecological management, and adaptive capacity in coastal governance. Kiger and Varpio (2020) explain that thematic analysis is useful for identifying and reporting patterns of meaning in qualitative data. Braun and Clarke (2022) also emphasize that thematic analysis requires careful interpretation, transparent coding, and coherent theme development. Final conclusions will be drawn by comparing themes across informants and data sources to produce a contextual explanation of how socio-ecological systems are integrated in community-based sustainable coastal management.

3. Results and Discussions

The findings show that community-based sustainable coastal management in Teluk Awur Village is shaped by the interaction between ecological change, local livelihood needs, community participation, and institutional support. Four main themes emerged from the analysis: local ecological knowledge as a basis for coastal action, community participation as shared responsibility, livelihood pressure as a constraint on sustainability, and institutional coordination as a key condition for socio-ecological integration. These themes indicate that coastal management is not only a matter of restoring mangroves or protecting coastal areas. It is also a social process that involves memory, experience, trust, local norms, and negotiation among actors. This pattern supports the socio-ecological systems perspective, which views coastal communities and ecosystems as interconnected and mutually shaping systems (Refulio-Coronado et al., 2021).

The first theme concerns the role of local ecological knowledge in understanding environmental change. Several informants explained that they recognized coastal degradation through daily experiences, such as changes in wave patterns, declining fish catches, reduced mangrove density, and increasing waste along the shoreline. One fisherman stated, "The sea is not the same as before. The waves reach closer to the settlement, and fish are harder to find near the coast." This statement shows that local communities do not understand ecological change only through scientific indicators. They read environmental change through livelihood disruption, spatial memory, and repeated observation. Baker and Constant (2020) argue that local ecological knowledge can strengthen conservation when formal institutions recognize it as valid knowledge. In this study, local knowledge became a practical guide for deciding where mangroves should be maintained, which areas were vulnerable to erosion, and when collective action was needed.

The second theme shows that community participation is present, but its meaning differs across social groups. Some residents described participation as direct involvement in mangrove planting, beach cleaning, tourism services, and village meetings. Others understood participation

as moral responsibility to protect the coast because it supports future generations. A community leader explained, “If we only wait for government programs, the coast will be damaged first. People here must move together because we live from this area.” This finding indicates that participation has both practical and symbolic meanings. It reflects labor contribution, local ownership, and emotional attachment to coastal space. However, participation was not always equal. Women, youth, and small-scale fishers were often involved in implementation, but they had limited influence in formal planning. This condition supports McKinley et al. (2021), who state that coastal engagement becomes meaningful when communities can influence the process, not only attend activities.

The third theme reveals that livelihood pressure often creates tension between ecological protection and economic survival. Informants acknowledged the importance of mangrove conservation and coastal protection, but they also faced daily economic needs. Fishers depended on access to coastal waters, tourism actors depended on visitor flows, and small traders depended on coastal activity. One female coastal trader said, “We support mangrove protection, but people also need income every day. If rules are made, they must consider how people eat.” This finding shows that sustainability programs can face resistance when they do not address livelihood realities. Lazzari et al. (2021) explain that coastal vulnerability is shaped by the interaction between ecological pressure and socio-economic exposure. In Teluk Awur, ecological awareness existed, but it had to compete with short-term income needs, limited livelihood alternatives, and unequal access to program benefits.

The fourth theme concerns institutional coordination and trust among actors. The findings show that community-based coastal management depends on collaboration among village government, community groups, local leaders, tourism actors, environmental agencies, and external facilitators. Documentation from village meetings and program reports showed that mangrove-related activities were often supported by formal programs, but continuity depended on local leadership and community initiative. One youth participant stated, “Programs come and go, but after the program ends, the people here must continue the work.” This statement reflects a common problem in community-based management, namely the gap between project-based intervention and long-term community stewardship. Celliers et al. (2023) stress that coastal governance requires clear stakeholder mapping because each actor has different power, interests, and responsibilities. In this study, weak coordination sometimes caused overlapping roles, unclear maintenance responsibilities, and limited follow-up after program completion.

The fifth theme shows that socio-ecological integration occurred through everyday practices rather than formal policy alone. Residents integrated ecological concerns into fishing decisions, mangrove maintenance, tourism management, waste handling, and informal education for younger community members. This integration was not always systematic, but it appeared in repeated local actions. For example, mangrove group members described how they selected planting areas based on soil texture, wave exposure, and community access. Tourism actors also adjusted visitor routes to avoid damaging young mangrove plants. A mangrove group member stated, “We know which place is too open to waves and which place can grow. That knowledge comes from trying many times.” This finding shows that socio-ecological integration develops through learning, trial, failure, and adaptation. Damastuti et al. (2023) found similar patterns in Central Java, where the success of community-based mangrove management varied depending on local ecological conditions and community capacity.

Discussion

The findings confirm that community-based coastal management must be understood as a socio-ecological process. The community did not separate ecological problems from social life. Coastal erosion, mangrove decline, fish scarcity, and waste accumulation were interpreted through their effects on income, settlement safety, tourism, and community identity. This supports the socio-ecological systems framework, which explains that environmental change and social adaptation

operate in an interconnected way. Kanan and Giupponi (2024) argue that coastal adaptation requires integrated attention to ecological risks and social capacities. The present study adds a qualitative perspective by showing that integration is not only found in policy design or management models. It is also found in local narratives, practical decisions, and everyday community action.

The role of local ecological knowledge is one of the most important findings of this study. Community members used experience-based knowledge to identify vulnerable coastal zones, understand seasonal changes, and evaluate mangrove growth. This finding is consistent with Baker and Constant (2020), who found that local ecological knowledge can improve marine conservation when it is treated as a legitimate source of planning information. However, this study also shows that local knowledge still faces institutional barriers. Formal programs often involve communities as implementers, but not always as co-designers. This creates a risk that local experience becomes symbolic rather than influential. Therefore, socio-ecological integration requires institutional mechanisms that allow local knowledge to shape planning, monitoring, and evaluation.

The findings on participation show both strength and limitation. Community members demonstrated strong attachment to coastal resources and willingness to engage in conservation activities. This supports Damastuti et al. (2022), who found that community involvement can strengthen mangrove biodiversity conservation in Central Java. However, the findings also show that participation was uneven. Some groups had more voice than others, especially local leaders and formal group representatives. Women, youth, and informal workers often contributed to activities but had less authority in decision-making. This finding extends previous studies by showing that participation should be assessed not only by the number of people involved, but also by who speaks, who decides, and who benefits.

Livelihood pressure emerged as a major constraint on sustainable coastal management. The community understood the importance of ecological protection, but daily income needs influenced how people responded to conservation rules and coastal programs. This finding is in line with Jozaei et al. (2022), who argue that coastal governance must connect social vulnerability with resilience. If conservation programs ignore livelihood insecurity, they may create compliance problems or weaken long-term community support. The finding also supports Masud et al. (2022), who emphasize that co-management works better when local needs and institutional responsibilities are balanced. In this study, sustainability depended on whether coastal management could protect ecosystems while also supporting income security.

The study also shows that institutional coordination affects the continuity of community-based coastal management. Program-based activities helped start collective action, but long-term management depended on local leadership, clear roles, trust, and follow-up support. This finding is consistent with Macamo et al. (2024), who show that community-based mangrove management depends on leadership, incentives, compliance, and social relations. The present study adds that institutional trust plays a central role in maintaining participation after external programs end. When residents believe that programs are temporary or only benefit certain actors, motivation weakens. When they see shared responsibility and visible benefits, participation becomes stronger.

The findings offer a new perspective on socio-ecological integration in community-based coastal management. Integration does not occur only through formal planning documents, conservation indicators, or institutional frameworks. It occurs when ecological knowledge, social relations, economic needs, and local governance meet in daily practice. This supports Oliveira et al. (2022), who emphasize the dynamic relationship between climate, coastal space, and community life. It also aligns with Quimby et al. (2023), who show that co-management can strengthen social-ecological resilience when resource governance is connected to community

needs. In Teluk Awur, integration was visible in how residents linked mangrove care, livelihood adaptation, coastal tourism, and collective responsibility.

The theoretical implication of this study lies in its contribution to the socio-ecological systems literature. It shows that SES integration should be studied not only through ecological indicators or institutional models, but also through lived experience, local meaning, and community interpretation. The study strengthens the argument that resilience is built through interaction between ecological recovery, social learning, participation, and institutional trust. The practical implication is that local governments and coastal managers need to design programs that give communities a stronger role in planning, not only implementation. Program design should include participatory mapping, livelihood-sensitive conservation rules, local monitoring teams, transparent benefit-sharing, and regular community reflection forums.

Future research can expand this study by comparing several coastal villages with different ecological conditions, livelihood structures, and governance arrangements. Further studies can also examine the role of women, youth, and informal workers in coastal sustainability because these groups often participate in daily coastal management but remain underrepresented in formal decision-making. Mixed-method research may also help connect qualitative insights with ecological data, such as mangrove density, coastal erosion rates, household income, or fish catch patterns. This direction can deepen understanding of how social and ecological indicators interact in community-based sustainable coastal management.

4. Conclusions

This study concludes that the integration of socio-ecological systems in community-based sustainable coastal management is formed through the connection between local ecological knowledge, community participation, livelihood needs, and institutional coordination. The findings show that coastal communities do not view environmental change as a separate ecological problem, but as part of their daily life, income, safety, and social identity. Local knowledge helps residents identify coastal vulnerability, evaluate mangrove growth, and respond to ecological change through practical experience. However, community participation remains uneven because some groups are involved mainly in implementation, while decision-making is still dominated by formal actors and local elites. This study contributes to the socio-ecological systems literature by showing that coastal resilience is not only built through ecological restoration or formal governance, but also through lived experience, social learning, trust, and everyday adaptive practices.

The findings have theoretical, practical, and policy implications. Theoretically, this study strengthens the view that sustainable coastal management requires an integrated understanding of ecological processes, local knowledge, institutional relations, and community livelihoods. Practically, local governments, village institutions, and coastal management groups need to design programs that place communities as co-planners, not only as implementers. Coastal governance should include participatory mapping, livelihood-sensitive conservation rules, transparent benefit-sharing, local monitoring, and regular community reflection forums. From a policy perspective, community-based coastal management should move beyond project-based intervention toward long-term institutional support. Future research can compare several coastal villages with different ecological and socio-economic conditions, or examine the specific roles of women, youth, and informal workers in strengthening coastal sustainability.

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